

## 5.62 *Stenella attenuata* (Gray, 1846)

English: Pantropical spotted dolphin

German: Schlankdelfin

Spanish: Delfín manchado

French: Dauphin tacheté

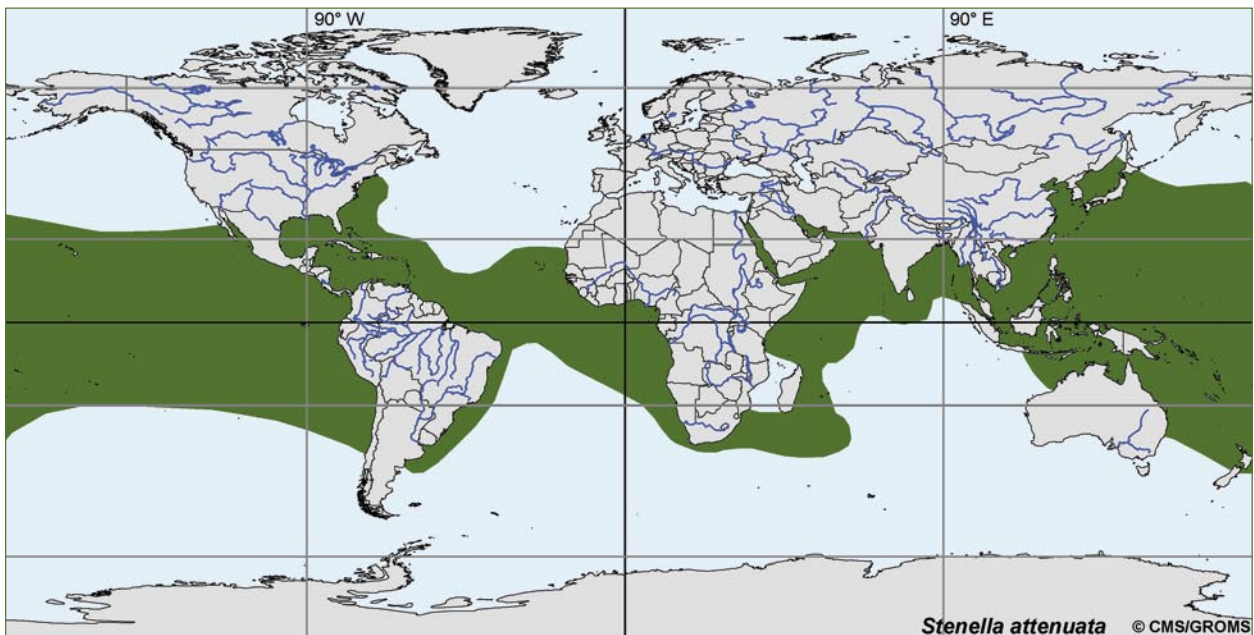


Drawing of *Stenella attenuata* © Wurtz-Artescienza.

### 1. Description

Adult *S. attenuata* can be identified by their long beak, sharply demarcated from the melon, slender body, strongly falcate (curved backward) fin and spotted body. The newborn calf is unspotted. In adults, the ventral spots fuse and fade to a medium grey, and the dorsal light spots intensify, sometimes to the point of making the animal appear nearly white above. In adults, the

tip of the beak is white. Details of coloration vary regionally. Adults range from 166 to 257 cm and weigh up to 119 kg. Males are on average slightly larger than females. As opposed to *S. frontalis*, with which it may easily be confounded, *S. attenuata* lacks a light spinal blaze and has a dorsoventral division of the peduncle. The dark ventral spots of *S. frontalis* are also lacking (Perrin, 2002).



Distribution of *Stenella attenuata* (mod. from Perrin and Hohn, 1994; © CMS/GROMS): Tropical and some warm temperate waters of the Atlantic, Pacific and Indian Oceans. It is found mainly where surface water temperatures are higher than 25°C (Carwardine, 1995).

## 2. Distribution

*Stenella attenuata* is distributed in tropical and warm temperate waters around the world, from roughly 30–40°N to 20–40°S (Jefferson et al. 1993). It ranges north to Massachusetts, the islands of Cape Verde, the northern Red Sea, Persian Gulf, Arabian Sea, Bay of Bengal, South China Sea, East China Sea, Pacific coast of northern Honshu, the Hawaiian Islands, and Baja California Sur. Vagrant to Santa Cruz County in California, and Cold Bay on the Alaska Peninsula (Rice, 1998).

It ranges south to Uruguay, Saint Helena, Cape Province, Timor Sea, New South Wales, New Zealand, and about 35°S off Talca, Chile (Rice, 1998). In the Atlantic it is known from relatively few localities; it is broadly sympatric there with the Atlantic spotted dolphin *S. frontalis*, but it may not occur as far north as that species (Perrin and Hohn, 1994).

This species varies geographically in cranial and postcranial measurements, and in body size and coloration, but in most of its range division into subspecies has not been attempted because too few specimens are available. However, in parts of the central and eastern Pacific, Perrin was able to distinguish Hawaiian, offshore, and coastal subspecies- the first two not yet named (the type locality of *S. attenuata* is unknown) (Rice, 1998):

*S. a.* subspecies B, the "Hawaiian spotted porpoise" of Perrin (1975). Inshore waters around the Hawaiian Islands.

*S. a.* subspecies A, the "Eastern Pacific offshore spotted porpoise" of Perrin (1975). Eastern tropical Pacific from about 14.5°W eastward to the immediate offshore waters between Baja California Sur and Colombia.

*S. a. graffmani* (Lönnerberg, 1934). Inshore waters within about 25 km from land, between the Golfo de California and Colombia. This is the "Eastern Pacific coastal spotted porpoise" of Perrin (1975) and the "coastal spotted dolphin" of Dizon et al. (1994).

## 3. Population size

*S. attenuata* is among the most abundant dolphins in the eastern tropical Pacific (Jefferson et al. 1993). It ranges second in abundance in the deeper waters of the Gulf of Mexico, the eastern tropical Pacific and Sulu Sea, and sixth in the tropical Indian ocean (Perrin 2002). Perrin and Hohn (1994 and refs. therein) esti-

mate the 1979 population levels at 1.7 million. The most recent estimates of absolute abundance in the eastern Pacific (Gerrodette, 1999) are 592,000 for the "north-eastern" stock, 710,000 for the "west/south" stock, and 73,000 for the "coastal" stock (*S. a. graffmani*). According to Jefferson and Schiro (1997), *Stenella attenuata* is the most common species of small cetacean in oceanic waters of the Gulf of Mexico. Jefferson (1996) counted 5,800 individuals in the north-western Gulf area.

The cetacean community of the Western Tropical Indian Ocean (WTIO) is similar to that of the eastern tropical Pacific (ETP) and the Gulf of Mexico (GM) in several respects. Regardless of ocean, three species comprised the majority of cetaceans in the community, *Stenella attenuata*, *S. longirostris*, and *S. coeruleoalba*, representing 62%–82% of all individuals for all species. However, the rank order of abundance for these three species differs with ocean. Most notably, *S. attenuata* is abundant in the ETP and GM but much less common in the WTIO. Although habitat preferences for *S. attenuata* appear to overlap considerably with those of *S. longirostris* in the ETP, results suggest there may actually be significant differences between these two species. Detailed analysis of oceanographic correlates of distribution will be necessary in order to understand fully the habitat requirements of these pelagic dolphins, often the most conspicuous elements of tropical cetacean communities around the world (Balance and Pitman, 1998).

Dolar et al. (1997) surveyed marine mammal distribution and abundance in the southern part of the Sulu Sea and north-eastern Malaysian waters. Population size estimates for pantropical spotted dolphin were 3,500 individuals. For the Eastern Sulu Sea, Dolar (1999) estimated a total population size of 13,000.

## 4. Biology and Behaviour

**Habitat:** In the eastern Pacific the pantropical spotted dolphin is an inhabitant of the tropical, equatorial and southern subtropical water masses. The waters in which the animal occurs with greatest frequency are those underlain by a sharp thermocline at depths of less than 50 m and with surface temperatures over 25°C and salinities less than 34 parts per thousand. These conditions prevail year round in the region north of the Equator called the "Inner Tropical" waters of the eastern Pacific. Occurrence in this core habitat is correlated with apparent multi-species foraging and feeding

behaviour. The species also occurs in closely similar waters south of the Equator that expand and contract greatly with season and year to year (Perrin and Hohn, 1994 and refs. therein).

In the Atlantic, *S. attenuata* is primarily a dolphin of the high seas and oceanic islands, but in the eastern Pacific a large-bodied race occurs along the coast from Mexico to Peru; it may feed on larger prey than does the oceanic form and may be an ecological counterpart of the large form of the endemic *S. frontalis* in Atlantic coastal waters (Perrin and Hohn, 1994 and refs. therein).

**Schooling:** A "school" (all of the animals seen at one time, or captured in one purse-seine set) may consist of from just a few dolphins to several thousand. Observations of schools captured in purse seines show that they are often formed of distinct subgroups containing cow-calf pairs, adult males, or juveniles (Perrin and Hohn, 1994 and refs. therein).

Spotted dolphins in the oceanic eastern tropical Pacific aggregate with yellowfin tuna, *Thunnus albacares*. Other participants in the aggregations include spinner dolphins (*S. longirostris*), skipjack tuna (*Katsuwonus petamis*), oceanic birds of several families, and less commonly other small cetaceans, sharks and billfish. The reason for these associations is not known but may have to do with foraging efficiency, protection from predators, orientation in the pelagic void, or some other factor or circumstance not yet understood. Tuna fishermen take advantage of the dolphin-tuna association in finding and catching tuna (Perrin and Hohn, 1994 and refs. therein). In the Western Tropical Indian Ocean (WTIO), Balance and Pitman (1998) recorded 26 mixed-species cetacean schools, 43 schools with which seabirds associated, and 17 schools associated with tuna. Notable among these were mixed aggregations of *Stenella attenuata*, *S. longirostris*, yellowfin tuna, and seabirds.

**Food:** The prey of the pantropical spotted dolphin is made up primarily of small epipelagic fish, squid and crustaceans, with some take of mesopelagic animals. Pregnant females may have feeding habits different from those of lactating females (Perrin and Hohn, 1994 and refs. therein).

Identified prey of *Stenella attenuata* include 56 species of fish and 36 species of cephalopods (Roberston and Chivers, 1997). The most frequently found fish were

lanternfish (family Myctophidae) at 40%, and the most frequently found cephalopods were trying squids (family Ommastrephidae) at 65%. The dominance of these primarily mesopelagic prey species and a significantly higher stomach fullness index for stomachs collected during the morning hours suggest that pantropical spotted dolphins feed at night when many mesopelagic species migrate toward the surface. Significant differences in prey composition by season and geographic region indicate that pantropical spotted dolphins are flexible in their diet and may be opportunistic feeders. Comparison of the diets of pregnant and lactating female dolphins revealed that lactating females increase both the proportion of squid in their diet and the quantity of food consumed.

Baird et al. (2001) studied diving and nighttime behaviour of pantropical spotted dolphins near the islands of Maui and Lana'i, Hawai'i, in 1999. Suction-cup-attached time-depth recorder/VHF-radio tags were deployed on six dolphins for a total of 29 h. Rates of movements of tagged dolphins were substantially lower than reported in pelagic waters. Average diving depths and durations were shallower and shorter than reported for other similar-sized odontocetes but were similar to those reported in a study of pantropical spotted dolphins in the pelagic waters of the eastern tropical Pacific. Dives (defined as >5 m deep) at night were deeper (mean = 57.0 m, maximum depth 213 m) than during the day (mean = 12.8 m, maximum depth 122 m), and swim velocity also increased after dark. These results, together with the series of deep dives recorded immediately after sunset, also suggest that pantropical spotted dolphins around Hawai'i feed primarily at night on organisms associated with the deep-scattering layer as it rises up to the surface after dark.

## 5. Migration

Seasonal migrations have been observed for the population in the coastal waters of Japan. Here, spotted dolphins move north in summer, and probably concentrate at the northern boundary of the Kuroshiro current. In winter they move south, reaching a migration peak in late October and early November (Reyes, 1991, and ref. therein).

In the eastern tropical Pacific tagging experiments show that movement of pantropical spotted dolphins may generally be onshore in fall and winter and offshore in late spring and summer. The minimum distance travelled by the tagged animals ranged from 7

to 582 nautical miles (Reyes, 1991, and refs. therein). Offshore spotted dolphins may be found as close to the coast as 16 nautical miles, where they overlap with the coastal form (Reyes, 1991, and refs. therein).

Reilly (1990) studied large-scale patterns of dolphin distribution and oceanography from research-vessel surveys conducted in the pelagic eastern tropical Pacific during June to November 1982, 1986 and 1987. Substantial changes were observed in relation to previously reported winter distributions for spotted dolphin schools. These dolphin species were sighted in abundance west of 120°W along 10°N coincident with seasonal shoaling of a thermocline ridge. Highest-density areas for the different species were clearly separated spatially, and the thermocline depths surface temperatures of sighting localities were statistically different between spotted/spinner dolphin schools and common dolphin schools.

## 6. Threats

**Direct catches:** Only Japan takes large numbers of spotted dolphins for human consumption in drive and harpoon fisheries. The catch in 1982 was 3,799 and annual catches between 1994 and 1997 ranged from 23 to 449 (Perrin, 2002 and refs. therein). The drive fishery for spotted dolphins began in 1959 and is thought to have caused a slight decline in the minimum age attainment of sexual maturity in females. Pantropical spotted dolphins are also taken in hand-harpoon fisheries in the Philippines, Laccadive Islands and Indonesia and Sri Lankan gillnet and harpoon fisheries (e.g. Dolar et al. 1994). A former drive fishery at Malaita in the Solomon Islands took several hundred or thousands of spotted dolphins annually in the 1960s. Small numbers are taken in numerous small subsistence fisheries for dolphins and whales around the world, e.g. at St Vincent in the Lesser Antilles (Perrin and Hohn, 1994 and refs. therein).

**Incidental catches:** The tuna fishery in the eastern tropical Pacific targets the pantropical spotted dolphin to catch yellowfin and skipjack tuna that often swim below the herds. This ecological association of tuna and dolphins is not clearly understood (Gerrodette, 2002). Annual mortality of spotted dolphins in the late 1980s was in the tens of thousands. Takes of hundreds of thousands per year in the 1960s and 1970s reduced the northern offshore stock of *S. attenuata* to an unknown degree (Perrin and Hohn, 1994 and refs. therein).

According to Wade (1995) mortality estimates from the period with the greatest kill of dolphins, 1959-72, are important for estimates of the level of depletion of these stocks from their unexploited population sizes. A redefinition of the geographical boundaries of offshore stocks of *Stenella attenuata* makes it necessary to estimate the annual kill for these newly defined stocks for 1959-72. Wade (1995) estimated that 4.9 million dolphins were killed by the purse-seine fishery over that fourteen-year period (1959-72), an average of 347,082 per year. Nearly all of the fisheries kill of pantropical spotted dolphins was of the north-eastern stock, totalling 3.0 million (211,612 per year). Estimates of kill for the eastern stock of spinner dolphins were similar to previous estimates, totalling 1.3 million (91,739 per year).

In the early 1990's, the kill declined to around 15,000 due to improved rescue techniques (Perrin and Hohn, 1994 and refs. therein). Gosliner (1999) summarises, that as the US brought dolphin mortality by its fishermen under control in the 1980's, the numbers of dolphins being killed again skyrocketed as a shrinking US fleet was replaced by those from Mexico, Venezuela, and other nations. Through the use of trade sanctions, and ultimately international co-operation, dolphin mortality has recently (1997) been reduced to levels generally believed to be biologically insignificant (0 dolphins in US fishery, ca. 3,000 in non-US fisheries).

Although tuna and dolphins are still herded and captured together in the net, the crew attempt to release the dolphins by a procedure called "backdown," while utilising various dolphin safety gear. Though a great majority of the dolphins are released unharmed, some die during the fishing operation. The Tuna-Dolphin Program of the Inter-American Tropical Tuna Commission (IATTC) is charged with monitoring this incidental mortality, studying its causes, and encouraging fishermen to adopt fishing techniques which minimise it. Since 1986, dolphin mortality has been reduced by 97%. Analyses of observer data show that many factors cause dolphin mortality, such as fishing areas; dolphin species and herd sizes; environmental factors; gear malfunctions; and crew motivation, skill, and decision-making. Given this, it is clear that there can be no simple solution. A combination of major and minor technological developments, training in their use, better decision-making skills, and constant pressure to improve performance are the basis of the current success (Bratten and Hall, 1997).

Nevertheless, the use of dolphins to locate and catch tuna will remain controversial as long as any of these cetaceans are killed or injured in the process (Gosliner, 1999). Gerrrodette (2002) states that by 1999, there was no clear indication of a recovery for northeastern offshore spotted dolphins. Several factors could be responsible for this:

- cryptic effects of repeated chase and encirclement on survival and/or reproduction (internal injuries, stress, hyperthermia), separation of nursing calves from their mothers during the fishing process. Indeed, Archer et al. (2001) report a calf deficit in the number of lactating spotted dolphin females being killed between 1973 and 1990. These unobserved deaths of nursing calves due to separation from their mothers during fishing indicate that the reported dolphin kill fails to measure the full impact of purse-seine fishing on spotted dolphin populations.
- unobserved or observed but unreported adult mortality,
- effects due to breakup of dolphin schools (increased predation, social disruption),
- ecological effects due to removing tuna from the tuna-dolphin association, and
- ecosystem or environmental changes.

The intense fishing pressure on tuna supports these hypotheses: Schools of 1,000 or more dolphins are estimated to be set on approximately once a week each on average, but such schools are estimated to represent just under one tenth of the animals in the northeastern offshore stock. Schools set on most often by tuna purse-seiners, containing from about 250 to 500 dolphins, are estimated to be set on between two and eight times each per year and are estimated to include approximately one third of the stock. An estimated one half of the stock occurs in schools smaller than 250 animals; schools of this size are estimated to be set on less than twice per year each (Perkins and Edwards, 1999).

Yang et al. (1999) also report incidental mortalities from chinese fisheries and Dolar et al. (1997) found that 4 of the 7 fishing villages surveyed in the Philippines reported directed and/or incidental spotted dolphin takes.

**Killing:** Dolphins and small whales of several species, including *S. attenuata*, interfere in hook-and-line fisheries for squid and yellowtail in the Iki Island region of Japan. Bounties have been paid to fishermen for dolphins killed since 1957. During the period 1976-1982 a total of 538 spotted dolphins were killed. The effect of these takes on the population is not known (Perrin and Hohn, 1994 and refs. therein).

**Pollution:** André (1988, in Perrin and Hohn, 1994) and André et al. (1990a, 1990b) reported levels, somatic distribution, and age-related changes in levels of Hg, Cd, Cr, Cu, Mn, Ni, Se, Zn, sDDT and PCBs in pantropical spotted dolphins from the eastern Pacific. Calmet et al. (1992) reported levels of radioactive isotopes of Pb, Cs and K in the same specimens. Cockcroft et al. (1991) reported levels of seven organochlorines in four specimens from Natal (both in Perrin and Hohn, 1994). Relatively high concentrations of DOT and PCBs have been found in some dolphin species in the eastern tropical Pacific and the western North Pacific. For example O'Shea et al. (1980, in Reyes, 1991) reported that DOT and PCB concentrations were higher in striped dolphins from the eastern tropical Pacific than in those from Japanese waters. The source of contamination in these tropical waters is unknown.

## 7. Remarks

According to Gosliner (1999) dolphin mortality in the eastern tropical Pacific tuna fishery is no longer considered by most marine mammal scientists to be biologically significant. "It may be that we are finally approaching the point at which further reductions in dolphin mortality using traditional fishing techniques are unlikely. Currently, about 88% of sets on dolphins result in no incidental mortality. Further reductions may be achievable only through new technical advances or a shift toward dolphin-safe fishing methods, raising other bycatch concerns". However, the question of whether any level of dolphin mortality incidental to tuna fishing is at all acceptable will no doubt continue to stir controversy (Gosliner, 1999). Furthermore, since some stocks like the north eastern offshore spotted dolphin stock show no sign of recovery (Gerrodette, 2002), there is still matter for concern (see above).

The eastern tropical Pacific and south-eastern Asian populations of *Stenella attenuata* are listed in Appendix II of CMS. The species is listed as "Lower Risk, conservation dependent" by the IUCN.

Range States include Colombia, Costa Rica, Ecuador, El Salvador, France (Clipperton Islands), Guatemala, Honduras, Mexico, the Netherlands, Nicaragua, Panama, Peru, Spain, the United States and Vanuatu, as well as all other maritime nations with tropical or semi-tropical waters.

Co-operative research is needed in order to continue with the reduction of incidental mortality, and to identify potential sources of habitat degradation, such as pollution. The species also occurs in Southern South America, so please see Hucke-Gaete (2000) for further recommendations in Appendix 1. General recommendations on Southeast Asian stocks can be found in Perrin et al. (1996) in Appendix 2.

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### 5.63 *Stenella clymene* (Gray, 1850)

English: Clymene dolphin

German: Clymene-Delphin

Spanish: Delfin clymene

French: Dauphin de Clymène

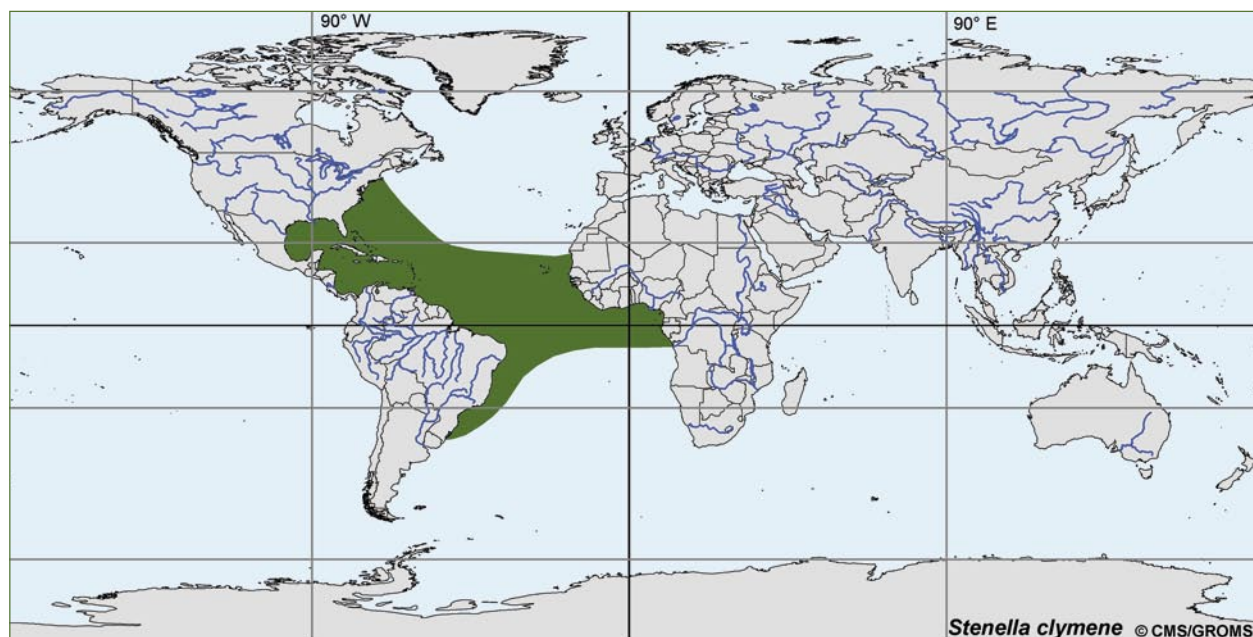


Drawing of *Stenella clymene* ©Wurtz-Artescienza.

#### 1. Description

The Clymene dolphin is small but rather stocky and has a moderately long beak. The dorsal fin is tall and nearly triangular to slightly falcate and flippers and flukes resemble those of other members of the genera *Delphinus* or *Stenella*. The coloration is tripartite: the belly is white, the flanks are light grey and the cape is dark grey. There is a dark grey line running down the length of the top of the beak, but the most distinctive

feature is a black "moustache" marking of variable extent at the top of the beak. With this exception, most of this species' external characters are very similar to those of the spinner dolphin. Body size reaches between 170–190 cm in females and 176–197 cm in males and maximum body mass recorded was 80 kg (Jefferson, 2002).



Distribution of *Stenella clymene* (mod. from Fertl et al. 2003; © CMS/GROMS): the species prefers the tropical, sub-tropical and occasionally the warm temperate waters of the Atlantic Ocean (see text above).

## 2. Distribution

The Clymene dolphin (*Stenella clymene*) is found in tropical and warm temperate waters of both the North and South Atlantic Oceans (Fertl et al. 2003). The northernmost record is from New Jersey and the southernmost from southern Brazil. It can be expected to occur along the eastern seaboard of the United States, throughout the Gulf of Mexico and Caribbean, along the north-eastern coast of South America, throughout the Equatorial Atlantic and along the entire tropical coast of West Africa (Perrin and Mead, 1994).

## 3. Population size

The scarcity of records of this species indicates that it may not be very abundant, at least in coastal waters. Considering the difficulty of distinguishing it from similarly marked species at sea, however, it may not be as rare as it would seem to be (Perrin and Mead, 1994). Based on capture records, *S. clymene* appears to be the most common cetacean in Ghana's coastal waters, but no individual stocks have been distinguished on the coasts of West Africa (van Waerebeek et al. 2000 and refs. therein). However, new West African specimens of *S. clymene* are evidence that the present unequal distribution of this species in the western and eastern parts of the tropical North Atlantic could be an artefact of poor sampling in African waters (Robineau et al. 1994).

Jefferson (1996) in a survey conducted in the north-western Gulf of Mexico from 1992 to 1993 estimated the local population of *S. clymene* at about 2,300 individuals.

## 4. Biology and Behaviour

Very little is known of the clymene dolphin's natural history.

**Schooling:** Schools tend to be much smaller than those of spinner dolphins (generally less than 50 animals; Jefferson et al. 1993). Perrin and Mead (1994) report that schools of this species may be segregated by sex and age; three mass strandings in Florida were of two females with calves, three adult males, and six adult males. Of 47 specimens from a mass stranding in Louisiana in 1985, 43 were males (164–197 cm), two were females (155 and 168 cm, probably immature) and two were of unknown sex.

Watkins and Moore (1982, in Perrin and Mead, 1994) observed groups of 1–10 animals around St Vincent in the Caribbean. The clymene dolphins were swimming

in close association with schools of spinner dolphins but remained clustered together and did not approach the vessel as closely as the spinners did. Three groups of clymene dolphins seen off the US coast consisted of three, eight and 15 animals. A school off West Africa consisted of approximately 50 dolphins. Schools of this species have also been seen in the company of common dolphins (*Delphinus delphis*) off West Africa (Perrin and Mead, 1994, and refs. therein).

**Food:** Clymene dolphins have been observed at sea only in deep water (250–5,000m or deeper). They may be night feeders on small fish and squids. The stomach of one stranded specimen contained one pair of small squid beaks (unidentified) and over 800 very small otoliths of fishes of the families Myctophidae, Argentiniidae and Bregmacerotidae. Most of the species represented are mesopelagic but known to reach the surface at night during the course of vertical migrations. One myctophid (*Lampanyctus* sp.) usually does not occur in surface waters even at night (Perrin and Mead, 1994, and refs. therein). Fertl et al. (1997) report on Clymene dolphins feeding during the daytime in a co-ordinated manner on schooling fish in the Gulf of Mexico in water 1,243 m deep.

## 5. Migration

no entries.

## 6. Threats

Clymene dolphins are taken by harpoon in small numbers in a subsistence fishery at St Vincent in the Lesser Antilles. They are captured incidentally in gillnets in Venezuelan waters and utilised for longline shark bait and for human consumption (Perrin and Mead, 1994 and refs. therein). Contaminant levels have not been recorded. They may be one of the species taken in tuna purse seines in the eastern tropical Atlantic (Jefferson et al. 1993) and have been recorded from by-catches in Brazilian fisheries (Zerbini and Kotas, 1998).

## 7. Remarks

The Clymene dolphin listed as "Data Deficient" by the IUCN. The species is not listed by CMS.

Range states include the US, Mexico, Belize, Honduras, Nicaragua, Costa Rica, Panama, Colombia, Venezuela, Guyana, Surinam, French-Guyana, Brasil, Cuba, Bahamas, Dominican Rep., Haiti, Mauretania, Senegal, Gambia, Guinea-Bissau, Guinea, Sierra Leone, Liberia, Cote D'Ivoire, Ghana, Togo, Benin, Nigeria, Cameroun, and Gabun.

The species is poorly known with respect to biology, life history, distribution and migratory habits. Further research on all aspects of its biology is needed. However, sightings at sea suggest a wide home-range, and individuals or groups thus may cross many international boundaries, especially in the Caribbean. Therefore, inclusion into appendix II of CMS is recommended. See further recommendations in Hucke-Gaete (2000) in Appendix 1.

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## 5.64 *Stenella coeruleoalba* (Meyen, 1833)

English: Striped dolphin, blue-white dolphin

German: Blauweißer Delphin

Spanish: Delfín listado

French: Dauphin bleu et blanc, dauphin rayé

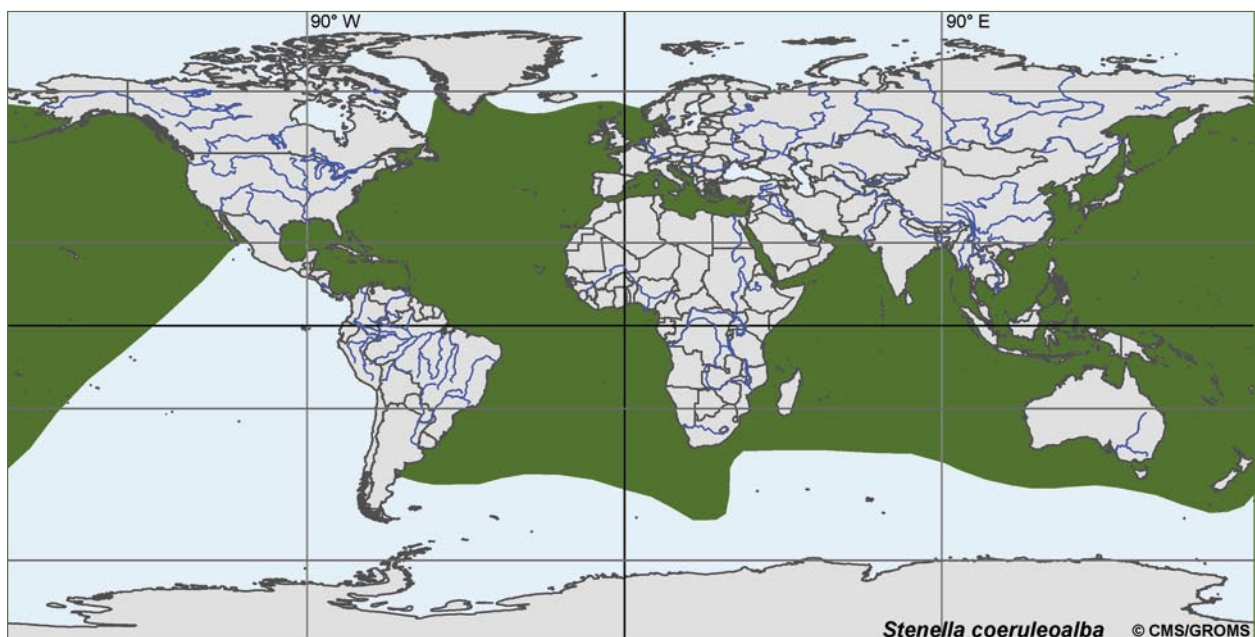


Drawing of *Stenella coeruleoalba* © Wurtz-Artescienza.

### 1. Description

The trivial name "*coeruleoalba*" refers to the diagnostic pattern of blue and white stripes and blazes along the lateral and dorsal sides of the body of these dolphins. The dorsal cape is muted blue or blueish-grey, usually invaded by a white to light grey spinal blaze. The sides are darker than the belly. Striped dolphins have a long beak, well demarcated from the melon and falcate dor-

sal fin. In the field, they are most likely confused with common dolphins (*Delphinus delphis*) and other similar-sized species, but can easily be distinguished by their robust body and coloration. The longest recorded specimen was 2.56 m and the maximum weight recorded was 156 kg. Mean body length in the western Pacific is 2.4 m for males and 2.2 m for females (Archer, 2002).



Distribution of *S. coeruleoalba* (mod. from Archer and Perrin, 1999 and Perrin et al. 1994; © CMS/GROMS): warm temperate, subtropical, and tropical waters around the world.

Striped dolphins show only moderate geographical variation in skeletal morphometrics, and little if any geographical variation in pigmentation pattern. However, several authors found slight but significant differences in body size between local populations in the eastern North Atlantic, the north-western Mediterranean, and the south-western Mediterranean (Rice, 1998). Calzada and Aguiar (1995) studied the variation in maximum body size of striped dolphins, in various areas of the Mediterranean Sea. Animals inhabiting the southern part of the Mediterranean are larger than those inhabiting the northern fringe. The southern fringe is characterised by stronger seasonality and lower density of dolphins, both factors likely to favour larger maximum individual body sizes in a population. The variation observed may reflect population stratification leading to a degree of genetic isolation within the western Mediterranean Sea. MtDNA differentiation also suggests that NE-Atlantic striped dolphins form a separate population from the Mediterranean population (Garcia-Martinez et al. 1999).

## 2. Distribution

The striped dolphin is distributed world-wide in tropical and temperate waters. It ranges north in the Atlantic to Newfoundland, southern Greenland, Iceland, the Faroes, and Denmark; in the Mediterranean Sea; and in the Pacific to the Sea of Japan, Hokkaido, about 40°N across the western and central Pacific, and British Columbia (Canada). The southern limit of its range is Buenos Aires in Argentina, Cape Province, Western Australia, New Zealand, and Peru (Archer and Perrin, 1999; Rice, 1998; van Waerebeek et al. 1998; Baird et al. 1994).

As for the other tropical dolphins, its known range is likely to expand greatly as knowledge accumulates about the cetacean faunas of South America, Africa and tropical Asia. Although Perrin et al (1994) state that it is not a common inhabitant of cold boreal waters as previously claimed, there are coldwater records, e.g. from Greenland and the Faroe Islands, and Syvertsen et al. (1999) report sightings/strandings from the Norwegian coast. Vagrants have even been recorded from Komandorskiye Ostrova (Rice, 1998). However, in the south van Waerebeek et al. (2000) did not report new sightings or strandings from West Africa. The transoceanic distribution shown in the map is likely, based on oceanographic conditions.

## 3. Population size

Würsig et al. (1998) assessed cetacean responses to survey ships and aircraft and found that *S. coeruleoalba* moved to avoid the ships in 33% of sightings. Their data indicate that density estimates for this species may tend to be biased downwards.

Based on sighting data in 1983–91, the total current striped dolphin population in Japanese waters is estimated at 821,000 with a standard error of 182,000 although questions of stock identity remain. Two concentrations of striped dolphin in the western North Pacific were identified. The first, estimated to comprise about 7,000 animals, was found between 20° and 30°N. The second, a large concentration of around 350,000 animals was located between 30° and 40°N. Relatively few striped dolphins were present in the nearshore waters off Japan, with an approximate population of 2,300 individuals (Perrin et al. 1994, and refs. therein).

In the eastern tropical Pacific, "relative" population estimates from annual survey cruises in 1986–90 range from 635,000 to 2,251,300 (Perrin et al. 1994, and refs. therein). Barlow (1995) estimated the abundance of *Stenella coeruleoalba* in California waters at 12,300 individuals between the coast and approximately 555 km offshore. Balance and Pitman (1998) found that *S. coeruleoalba* was the second most important species sighted in the Western Tropical Indian Ocean (14% of all cetaceans) compared to the Eastern Tropical Pacific (33%) and Gulf of Mexico (10%).

Goujon (1996) conducted a sighting survey in 1993 and estimated population sizes of 74,000 striped dolphins in the fishing grounds of the albacore tuna driftnet fishery in the Bay of Biscay. In the western Mediterranean, it is the most common cetacean. The post-epizootic western Mediterranean population was estimated at 225,000 individuals. It was the most abundant species (43.5%) in recent surveys of the central Mediterranean (Perrin et al. 1994, Reyes, 1991 and refs. therein).

In the regions of Valencia and Murcia (Spain) in the western Mediterranean the absolute density estimated was 0.416 individuals/km<sup>2</sup> and total abundance was 12,010 individuals (Gomez de Segura et al. 2003). Mean relative density in the whole area was 0.43 individuals/nm. A very high dolphin density area was found in the north of the Ibiza channel with a highest

relative density of 9.2 individuals/nm. There were no seasonal changes in either the absolute density or in the distribution of this species in the area.

#### 4. Biology and Behaviour

**Habitat:** Striped dolphins are basically pelagic, traveling in large groups of several hundreds and even thousands of individuals (Reyes, 1991). For the Western Pacific, Toshio (1999) reports that in summer striped dolphins are found in three geographical aggregations in the Pacific waters off Japan, between 20 and 42 °N. Occurrence is seasonal in the northern part of the range. They are uncommon in the Sea of Japan, East China Sea and Ryukyuan waters.

In the eastern Pacific, the distribution of striped dolphins tends to be complementary to that of the more strictly tropical *S. longirostris* and *S. attenuata*. Although there is great overlap, striped dolphins tend to be more frequent in areas where spinner and spotted dolphins are less frequent. They prefer areas with large seasonal changes in surface temperature and thermocline depth and with seasonal upwelling. Reilly (1990, in Perrin et al. 1994) found that year-round spatial separation in mean habitat features is maintained between the species, with striped dolphins intermediate between common and spinner/spotted dolphins in their oceanographic preferences.

Off South Africa, the species is oceanic, occurring beyond the continental shelf over depths of over 1,000 m, and its distribution is correlated with the warm Agulhas Current.

In the eastern North Atlantic, it is found in deep water (greater than 1,000 m) past the continental slope (Perrin et al. 1994 and refs. therein).

In western North Atlantic waters striped dolphins seem to be confined to the Gulf Stream or the waters off the continental slope (Davis et al. 1998).

In the Strait of Gibraltar, it is found in waters of 600 m or more depth (Hashmi, 1990).

Information from the Mediterranean shows that these dolphins may be found at waters deeper than 100 m (Reyes, 1991). According to Bourreau and Gannier (2003) striped dolphins in the Mediterranean are rather pelagic, mean water depths in sighting areas being 1,760 m.

Griffin (1997) reports that sighting rates of *Stenella coeruleoalba* increased with decreasing copepod density and increasing copepod diversity. Zooplankton community structure was found useful in understanding oceanographic characteristics of the habitat of odontocete species.

**Schooling:** Schools are of varying size and composition. Of 45 schools examined from off the coast of Japan, most (86%) contained fewer than 500 individuals. The mean school size was 101 animals. Schools moving south with the retreating front of the Kuroshio Current are larger than those moving north earlier in the year. Schools in the eastern North Atlantic more commonly have 10–30 individuals and rarely reach the hundreds. In the western Pacific, three major types of schools are recognised: juvenile, adult and mixed, the latter being divided into breeding and non-breeding schools. Juvenile schools may migrate closer to the coast than adult and mixed schools. Calves remain in adult schools until 1 or 2 years after weaning and then leave to join juvenile schools (Perrin et al. 1994 and refs. therein).

**Food:** Cephalopods dominated in the stomach contents of stranded striped dolphins on the Mediterranean coasts of France, Spain, and Italy, while myctophid fishes predominated in specimens from Japan and South Africa. Blanco et al. (1995) found that the cephalopods *Albraliopsis pfefferi*, *Onychoteuthis banksii*, *Todarodes sagittatus* and *Brachioteuthis riisei* were dominant in stomach samples from the western Mediterranean.

Feeding depth may extend to below 200 m and down to 700 m (Archer, 2002); 75–80% of the prey in the Japanese and South African material had organs of luminescence. Individual fish in the stomachs of the animals captured off Japan ranged in length from 60 to 300 mm (Perrin et al. 1994 and refs. therein; Santos et al. 2001a, 2001b).

Spitz et al. (2003) found that the diet of top predators varies according to food availability both in terms of quantity and composition. They analysed the contents of 23 stomachs from striped dolphins stranded on the coast of the Bay of Biscay, France between 1999 and 2002. Results were compared to similar samples analysed during the early 1980's. Observed trends were linked to biomass indices provided by groundfish surveys carried out by Ifremer on the eastern conti-

mental shelf of the Bay of Biscay. The most striking result was the opposite temporal trend of two fish species: *Gadiculus argenteus* and *Atherina presbyter*. The first species was not found in stomach contents from 1999 to 2002, whereas it was the second most abundant species in the early 1980's (28% by number and 14% by mass). The second species was most prominent in the diet of *S. coeruleoalba* between 1999 and 2002, representing 16% by number and 17% by mass, compared with 8% and 4% respectively in the 1980's. These changes agree with the trends observed in the groundfish survey biomass indices. The biomass of *G. argenteus* has been decreasing since 1992 and has been in very low abundance since 1997. Its spatial distribution has also reduced during the same period. By contrast, the biomass of *A. presbyter* recently increased (notably in 1995, 1998 and 1999) with a threefold increase in its occurrence in groundfish survey trawls since 1994. In summary, the diet of the striped dolphin reflects changes in the relative abundance of these two fish species according to groundfish survey trawls.

## 5. Migration

While in some regions (e.g. portions of the US east coast) the striped dolphin is encountered in all seasons, in other areas it appears to be associated with the fronts of warm oceanic currents that move seasonally and produce sporadic warm-water intrusions and meanders. In Japanese waters, the species is associated with the northern boundary of the warm Kuroshio Current, which extends up to 46°N in the summer and retreats to 33°N in the winter. It appears earlier in the season than *Stenella attenuata*, consistent with the hypothesis that the latter is the more tropical (Perrin et al. 1994 and refs. therein). Striped Dolphins approach the coast in September and October, and move southward along the coast, apparently dispersing into the East China Sea for the winter. In April they return along roughly the same route, but further offshore. Eventually they leave the coast to summer in the pelagic North Pacific. Segregation by age is observed (Reyes, 1991).

Seasonal movements may also occur in the Mediterranean. The dolphins move towards the northern part of the basin as the sea surface temperatures in the southern part increase. Sighting data also suggest seasonal movements of this species in the eastern tropical Pacific (Perrin et al. 1994; Reyes, 1991 and refs. therein).

Gannier (1999) investigated movements in the Ligurian Sea to describe the distribution shift off the French

Riviera. Night acoustic results show the presence and intense feeding activity of striped dolphins close to the shelf break. Day distribution shows a marked preference for the open sea. In near-shore waters the relative abundance index of 2 dolphins per km in the morning falls to a minimum of 0.25 dolphins per km during the afternoon and then recovers to an evening level of 0.98 dolphins per km. The distribution shift is supported by the description of an average movement pattern computed from 146 records: morning offshore and evening inshore movements are clearly shown. This study presents the scheme of a horizontal diel migration cycle, consistent with the nocturnal feeding of dolphins close to the shelf, and a diurnal offshore-inshore movement, whose motivation is not precisely known.

## 6. Threats

**Direct catch:** The largest direct catches have been taken in Japanese waters, in drive and hand-harpoon fisheries at several locations that date back to at least the Meiji period (1868-1912). The catches were voluntarily reduced beginning in 1981 and have since varied between 358 (in 1987) and 4,883 (1981), averaging 2,830 during the period 1981-89. Between 1989-1993, the average catch has dropped to 1,028. Toshio (1999) reports that Japanese multispecies dolphin fisheries now receive an annual quota of 725. Fragmented information on morphology, life history, pollutant levels and genetics suggests that the striped dolphins taken by Japanese fisheries are from more than one population, with varying proportions among fisheries and perhaps over time.

Striped dolphins were also taken in the former drive fishery at Malaita in the Solomon Islands and in the harpoon fishery for small cetaceans at St Vincent. Other such small indigenous fisheries may exist elsewhere. Small numbers were taken by French and Spanish fishermen for human consumption in the Mediterranean (Perrin et al. 1994 and refs. therein; Jefferson et al. 1993).

In the Northeast Atlantic, striped and common dolphins were harpooned to supply food for consumption on board or to scare them away from tuna trolling lines. It is difficult to ascertain the number of dolphins taken in this way, but it has been estimated in the thousands (Reyes, 1991).

**Incidental catch:** Incidental catches are known to occur in gill nets in the north-eastern Indian Ocean, in tuna

purse seines in the eastern tropical Pacific, in fisheries in the north-eastern Atlantic, in drift nets, purse seines and other gear in the Mediterranean, in various gear off the coast of Japan, in drift gill nets in the North Pacific, and probably occur in similar fisheries in tropical and warm-temperate waters around the world. Although rare, striped dolphins have also been caught in shark nets in Natal and South Africa (Perrin et al. 1994 and refs. therein).

A driftnet fishery for swordfish in the waters surrounding the Italian Peninsula was reported to have caught 68 striped dolphins among several other cetaceans in the period 1986–1988. These are considered underestimates of the total catch because the fishermen do not report all of the catches and because the area surveyed to document the catch was small relative to the total extent of the fishery. Some are taken by pelagic purse seines, but fishermen may allow the animals to escape (Reyes, 1991 and refs. therein).

Silvani et al. (1999) investigated by-catch rates in the Spanish driftnet fishery operating since 1994 on the Mediterranean side of Gibraltar Strait. The by-catch rate of dolphins (3 species in roughly similar proportions, including *S. coeruleoalba*) was 0.1 individuals per km of net set. The total catch of dolphins was estimated at 366 animals for the 1993 fishing season and 289 for that of 1994. If these figures are added to the undetermined catches of dolphins by the Italian and Moroccan driftnet fleets also operating in the region, it is possible that these catches are not sustainable. Variation in sighting and stranding frequency suggests that striped dolphins may have increased in numbers in recent decades. However, this progressive increase may have run parallel to a reduction in carrying capacity of its habitat. This suggestion is supported by the late age at reaching sexual maturity observed in the Mediterranean population as compared to other conspecific or even congeneric populations (Aguilar, 2000).

Antoine et al. (2001) evaluated that by-catch rates in the tuna drift-net fishery in the North East Atlantic were to 90% composed of *Delphinus delphis* and *Stenella coeruleoalba*. Mean catch rate by trip in the years 1992–1993 were 4.7 striped dolphins per km of net and per day. Such rates are similar to those estimated in other driftnet fisheries. Goujon (1996) estimated the annual additional mortality linked to the driftnets in the Bay of Biscay albacore tuna fishery to 1.8% for the striped dolphin (this estimate must be increased by

30% in order to take into account the whole European albacore tuna driftnet fishery). For the striped dolphin the long term possibility of a significant population decrease cannot be excluded.

In the South West Atlantic, by-catch of *S. coeruleoalba* was noted by Zerbini and Kotas (1998) off Brazil.

**Pollution:** Contaminants have been studied more intensively in this species than in any other cetacean. A long series of papers has reported the levels, accumulation rates, distribution, relationships and transfer dynamics of organochlorine compounds and heavy metals in striped dolphins taken in the Japanese drive fishery. Levels of organochlorines were similar to those in other small cetaceans in the same region and higher than levels in the southern hemisphere. Other areas sampled include the Mediterranean, the Atlantic coast of France, Wales, the US east coast and the eastern tropical Pacific (Perrin et al. 1994 and refs. therein).

According to Reyes (1991 and refs. therein), extremely high concentrations of heavy metals, DOT and PCBs are reported in specimens from the Mediterranean and Japan. The presence of high levels of heavy metals was associated with lung pathology in Mediterranean cetaceans. Recent studies revealed high levels of mercury in striped dolphins from the Ligurian, Adriatic, and Tyrrhenian Seas (Cardellicchio, 2000).

Monaci et al. (1998) found that mercury levels were higher in tissues from animals stranded on the Italian coasts and in skin biopsies obtained in the Tyrrhenian and Ligurian Seas, than in the respective Spanish samples. This is probably related to Hg pollution from the natural weathering of cinnabar ores in central Italy. Geographical differences in trace-element accumulation patterns may reflect the existence of two different populations of *Stenella coeruleoalba* in the western Mediterranean.

According to Aguilar (2000) tissue levels of organochlorine compounds, some heavy metals and selenium are high in Mediterranean samples and exceed threshold levels above which detrimental effects commonly appear in mammals. However, apart from the indication that these levels may have acted as triggering factors in the 1990–1992 epizootic by depressing the immune system of diseased individuals and potential lesions in the ovaries, no information on pollutant-related effects is available.

**Overfishing:** The European anchovy is the most heavily exploited pelagic resource in the Mediterranean, where some other stocks of pelagic fish are already over-exploited. Since striped dolphins are reported to eat anchovies and sardines in the area, this could eventually become either a source of conflict with the commercial fisheries or a potential threat for dolphin populations (Reyes, 1991). The 1990-1992 epizootic devastated the whole Mediterranean population; over one thousand corpses were examined in the western Mediterranean alone, but the toll was probably much higher. The causative agent of the die-off was a morbillivirus, but the effect of some pollutants and decreased food availability were suggested as triggering factors. Depletion of fish and cephalopod resources is widespread in the Mediterranean and, given that the diet of striped dolphins includes commercial species, this undoubtedly has a potential for limiting population numbers (Aguilar, 2000).

### 7. Remarks

To date, striped dolphins have faced relatively few threats compared with other small cetacean species, although very little is known about the species in some areas. However, some discrete populations are affected either by both direct and indirect catches or by habitat encroachment. In particular the direct catches off the Pacific coast of Japan are a matter of concern, as was expressed by the International Whaling Commission. The levels of contamination in the Mediterranean Sea, coupled with the increasing incidental catches in the driftnet fishery and reduced prey availability represent the major threats for this and other cetacean species in the area (Reyes, 1991).

*Stenella coeruleoalba* is categorised as "Lower Risk, conservation dependent" by the IUCN. The eastern tropical Pacific population and the western Mediterranean population are included in Appendix II of CMS. However, observations off the coast off Japan also indicate migratory behaviour in these waters. Range states concerned in these waters are Japan, North and South Korea, the Peoples Republic of China and Taiwan (see Perrin et al. 1996 in Appendix 2). Therefore, it is recommended that the West Pacific Stock also be included in Appendix II of CMS.

Range States for the western Mediterranean population are Algeria, France, Italy, Malta, Monaco, Morocco, Spain and Tunisia. Range States for the ETP populations are Colombia, Costa Rica, Ecuador, El Salvador,

France (Clipperton Island), Guatemala, Honduras, Mexico, the Netherlands, Nicaragua, Panama, Peru, Spain, the United States and Vanuatu (see Hucke-Gaete, 2000 in Appendix 1).

Further research should be focused on stock identity and abundance, the effects of direct and incidental mortality, and the effects of pollutants and other sources of habitat disturbance on dolphin populations, in particular in the western Mediterranean (Reyes, 1991).

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## 5.65 *Stenella frontalis* (G. Cuvier, 1829)

English: Atlantic spotted dolphin

German: Zügeldelphin

Spanish: Delfín pintado

French: Dauphin tacheté de l'Atlantique

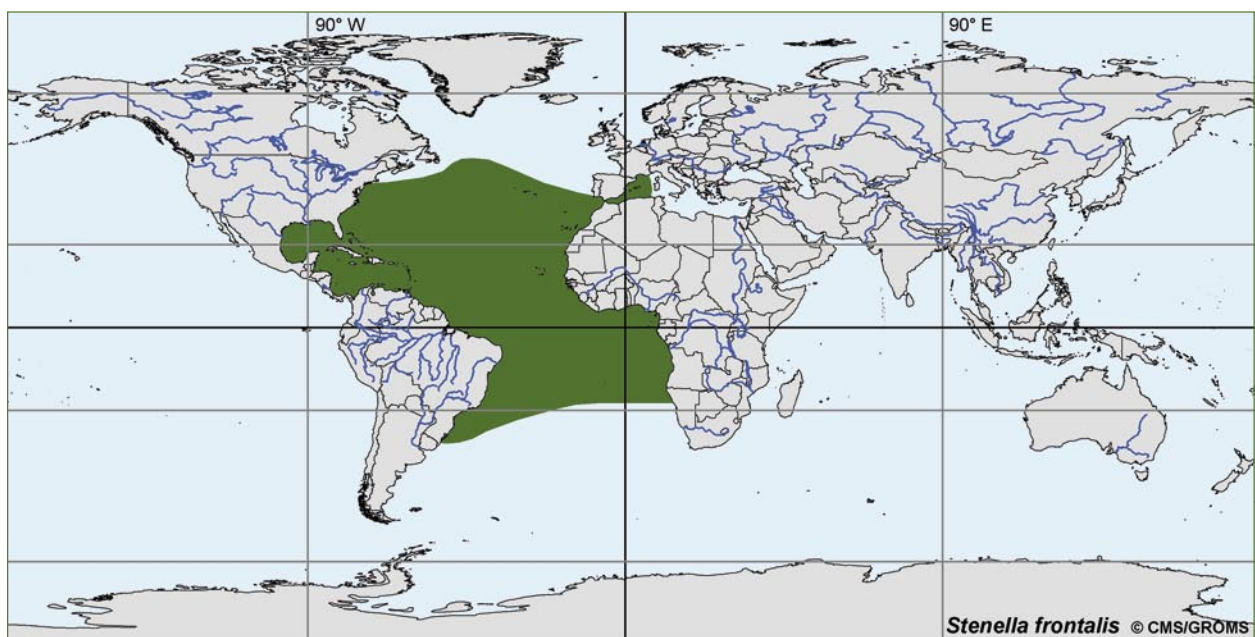


Drawing of *Stenella frontalis* © Wurtz-Artescienza.

### 1. Description

*S. frontalis* can be distinguished from *S. attenuata*, which also occurs in the tropical Atlantic, by its spinal blaze which sweeps up into the dorsal cape. In addition, the peduncle does not exhibit the dorsoventral division into darker and lighter lower halves observed in *S. attenuata*. Animals of this species are not always spotted, unlike the smaller or more delicate dark form

occurring in the Gulf Stream and central North Atlantic, or as heavily spotted and therefore almost white like the large form which is found on both sides of the Atlantic. Usually, spots first appear at 2–6 years of age and increase in size and density up to 16 years. The beak is of medium length and sharply demarcated from the melon and the dorsal fin is falcate. Adult size



Distribution of *Stenella frontalis* (mod. from Perrin et al. 1994; © CMS/GROMS). Warm, temperate, subtropical and tropical waters in the North- and South-Atlantic.

ranges from 166 cm to 229 cm and mass reaches up to 143 kg (Perrin, 2002).

There is a marked regional variation in the size and shape of the skull, and in adult body size (Perrin et al. 1987, in Rice, 1998). The largest individuals inhabit the coastal waters of the south-eastern United States; these are the animals that long went under the name *S. plagiadon* (Cope, 1866), and they may yet be recognised as a valid subspecies once a range-wide study has been completed (Rice, 1998). Although a smaller, less spotted form seems to be more pelagic than a larger, heavily spotted form (Carwardine, 1995), no populations or subspecies were formally recognised by 2000 (van Waerebeek et al. 2000).

## 2. Distribution

*Stenella frontalis* ranges in the tropical and warm temperate Atlantic, north to the Gulf of Mexico, Cape Cod, the Azôres, and the Canary Islands, and south to Rio Grande do Sul in Brazil, Saint Helena, and Gabon. A synonym is *Stenella froenata* (F. Cuvier, 1829) (Rice, 1998). The species is well documented from Equatorial Guinea and Côte d'Ivoire, with recent sightings at sea off Senegal (van Waerebeek et al. 2000 and refs. therein). The range therefore extends roughly from about 50°N to 25°S (Jefferson et al. 1973).

## 3. Population size

Atlantic spotted dolphins are thought to be the most common offshore species in the Gulf of Mexico and off the south-eastern United States, but efforts in the 1980s to estimate abundance in the Gulf and on the mid- and North Atlantic continental shelf did not attempt to differentiate between this species and the pantropical spotted dolphin, *S. attenuata* (Perrin et al. 1994 and refs. therein). There is no data available from West Africa, but the few records suggest that it is not abundant or that it has an offshore distribution (van Waerebeek et al. 2000).

## 4. Biology and Behaviour

**Habitat:** The large, heavily spotted form of the Atlantic spotted dolphin along the south-eastern and Gulf coasts of the United States inhabits the continental shelf, usually being found inside or near the 100-fathom curve (within 250–350 km of the coast) but sometimes coming into very shallow water adjacent to the beach seasonally, perhaps in pursuit of migratory forage fish. It is usually replaced in nearshore waters by the bottlenose dolphin, *Tursiops truncatus*. In the

Bahamas, Atlantic spotted dolphins spend much time in shallow water (6–12 m) over sand flats. The smaller and less-spotted forms that inhabit more pelagic offshore waters and waters around oceanic islands are less well known in their habitat requirements (Perrin et al. 1994 and refs. therein; Jefferson and Schiro, 1997). However, as the map indicates, the species is also known from far-offshore Gulf-stream and the mid-tropical Atlantic (W. Perrin, pers. comm.).

Davis et al. (1998) characterised the physical habitat of cetaceans found along the continental slope in the north-central and western Gulf of Mexico. Atlantic spotted dolphins were consistently found in the shallowest water on the continental shelf and along the shelf break within the 250-m isobath (Davis et al. 1996). In addition, the bottom depth gradient (sea floor slope) was less for Atlantic spotted dolphins than for any other species.

**Schooling:** Small to moderate groups, generally of fewer than 50 individuals, are characteristic of the Atlantic spotted dolphin. Coastal groups usually consist of 5 to 15 animals (Jefferson et al. 1993). On both coasts of northern Florida, moving groups may consist of up to 100 individuals and may attract other, smaller groups that join the large group briefly. Segregated schools of subadults and adults without calves and of adults with calves have also been observed (Perrin et al. 1994 and refs. therein).

In a new report from the Canary Islands maximum group size of *S. frontalis* is given as 650 animals (mean 40) out of 321 sightings between 1994–2001 (Ritter, 2003).

Herzing and Johnson (1997) observed interspecific interactions between free-ranging Atlantic spotted dolphins and bottlenose dolphins in Bahamian waters. Mixed-sex, mixed-species adult groups (including pregnant females) were seen foraging together and travelling together.

**Food:** A wide variety of fish and squids are taken by this species (Jefferson et al. 1993): The stomach of a specimen captured off northern Florida contained a large number of small cephalopod beaks, and dolphins of this species have been observed to feed on small clupeoid and carangid fishes and large squid and to follow trawlers to eat discarded fish. Observers in the north-eastern Gulf of Mexico have reported that

small squid have been regurgitated during captures of spotted dolphins (Perrin et al. 1994). Fertl and Würsig (1995) report that in the Gulf of Mexico Atlantic spotted dolphins fed in a co-ordinated manner and herded a school of clupeid fish into dense balls against the sea surface. While such feeding activity for other delphinid species has been well-described nearshore, this is one of the first reports of co-ordinated feeding offshore.

Clua and Grosvalet (2001) report that each summer the presence of large concentrations of bait fish in the area of the central Azores Islands gives rise to mixed-species feeding aggregations usually at dawn and dusk. The encircling of prey initiated by common dolphins (*Delphinus delphis*), often mixed with spotted dolphins (*Stenella frontalis*), results in the formation of a compact 'ball' of several thousand prey fish close to the surface. Other dolphins, in particular the bottlenose (*Tursiops truncatus*), also eat the prey fish, whose high concentration makes them easy to capture. Large tunas (*Thunnus thynnus*, *Thunnus albacares*) sometimes participate in the phenomenon. Seabirds (mainly cory's shearwaters, *Calonectris diomedea borealis*) are always present throughout the few minutes during which the entire collective food hunt takes place. Clua and Grosvalet (2001) show that it is the tunas that generate and benefit from the aggregation with dolphins, rather than the contrary.

Dives to 40–60 m and lasting up to 7 min have been recorded, but most time is spent at less than 10 m (Davis et al. 1996).

## 5. Migration

The Gulf of Mexico population (and possibly other populations as well) moves close to shore during summer. Usually, these dolphins are found over the offshore continental shelf (Carwardine, 1995).

Davis et al. (1996) report on the diving behaviour and daily movements of a rehabilitated Atlantic spotted dolphin that was tracked in the north-western Gulf of Mexico for 24 d using satellite telemetry. During that time, the animal travelled a total of 1,711 km at a mean travelling speed of 0.8 m/s. The mean minimum distance travelled daily was 72 km. Although this single animal can hardly be considered representative for the species, it illustrates the habitat use and movements within the marine habitat. International borders (e.g. Between Texas and Mexico) are not limiting for wild populations.

Mignucci et al. (1999) assessed cetacean strandings (including Atlantic spotted dolphins) in waters off Puerto Rico and the United States and British Virgin Islands. Between 1990 and 1995, the average number of cases per year increased from 2.1 to 8.2. The seasonal pattern of strandings was not found to be uniform, with a high number of strandings occurring in the winter and spring. The monthly temporal distribution showed an overall bimodal pattern, with the highest number of cases reported for February, May and September.

## 6. Threats

**Direct catches:** Atlantic spotted dolphins are taken in a direct fishery for small cetaceans in the Caribbean. Direct takes may also occur off the Azores and off West Africa (Jefferson et al. 1993; Perrin et al. 1994).

**Incidental catches:** Some are probably taken incidentally in tuna purse seines off the West African coast. However, there are no reliable estimates of the number of animals taken in these fisheries (Jefferson et al. 1993; Carwardine, 1995), but it may be considerable. Atlantic spotted dolphins are also captured incidentally in gill nets in Brazil and Venezuela (e.g. Zerbini and Kotas, 2001). In Venezuela, the dolphin carcasses are utilised for shark bait and for human consumption (Perrin et al. 1994).

Mignucci et al. (1999) found that the most common human-related cause categories observed in strandings were entanglement and accidental captures, followed by animals being shot or speared. Nieri et al. (1999) report that in 1995, a large number of dolphins washed ashore on the sandy beaches north of Nouakchott, the capital of Mauritania. Officers from the Parc National du Banc d'Arguin and researchers from the University of Barcelona surveyed the coastline to assess the number of corpses and the cause of death, which was attributed to fishery interaction.

For another fishery Delgado (1997) reports that dolphins in Campeche Sound, Mexico, stayed behind shrimp catch vessels and ate the discarded bycatch (mainly at night). Because dolphins respected trawl net position, the probability of incidental catch appeared low.

**Pollution:** Watanabe et al. (2000) determined concentrations of polychlorinated biphenyl congeners (PCBs) and organochlorine pesticides in the livers of Atlantic spotted dolphins found stranded along

the coastal waters of Florida, USA, during 1989 to 1994. The PCBs were the most predominant contaminants followed in order by DDTs, chlordanes, tris(4-chlorophenyl)methane (TCPMe), tris(4-chlorophenyl)methanol (TCPMOH), hexachlorobenzene, and hexachlorocyclohexane isomers. Among the cetaceans analysed, organochlorine concentrations were greatest in bottlenose dolphins followed by Atlantic spotted dolphins and pygmy sperm whales. The hepatic concentrations of TCPMe and TCPMOH in bottlenose dolphins and Atlantic spotted dolphins were greater than those in the blubber of marine mammals of various regions, which suggested the presence of sources for these chemicals along the Atlantic coast of Florida.

## 7. Remarks

Atlantic spotted dolphins seem to prefer inshore waters on both sides of the tropical Atlantic and may venture even further. Satellite telemetry showed that the species is capable of moving considerable distances, and stranding data show seasonal peaks. These data show that movements and home range size are likely to stretch across international boundaries.

Range states include the US, Mexico, Belize, Honduras, Nicaragua, Costa Rica, Panama, Colombia, Venezuela, Guyana, Suriname, French-Guyana, Brasil, Cuba, Bahamas, Dominican Rep., Haiti, Senegal, Gambia, Guinea-Bissau, Guinea, Sierra Leone, Liberia, Côte D'Ivoire, Ghana, Togo, Benin, Nigeria, Cameroun, Gabun, Rep. Congo, Dem. Rep. Congo, Angola and Namibia.

Inclusion in Appendix II of CMS is therefore strongly suggested

The species is listed as "Data Deficient" by the IUCN.

Atlantic spotted dolphins also occur in South America, so please see HUCKE-GAETE (2000) in Appendix 1 for further recommendations. Range states in the Caribbean should be encouraged to investigate into and reduce accidental by-catch.

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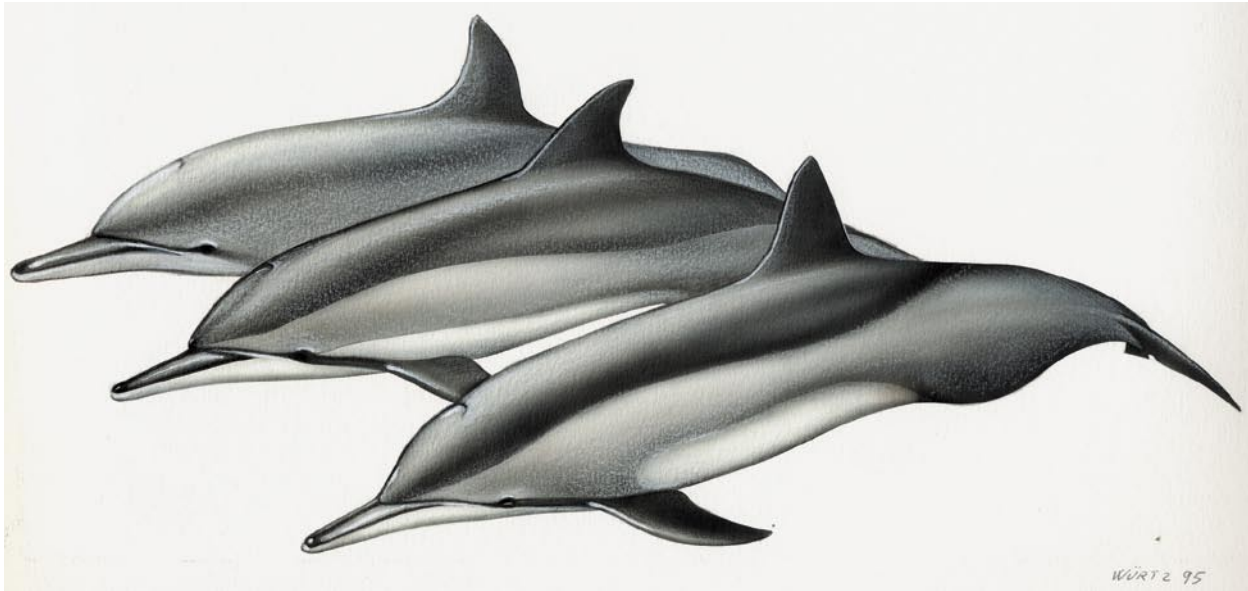
## 5.66 *Stenella longirostris* (Gray, 1828)

English: Spinner dolphin

German: Ostpazifischer Delphin

Spanish: Estenela giradora

French: Dauphin longirostre

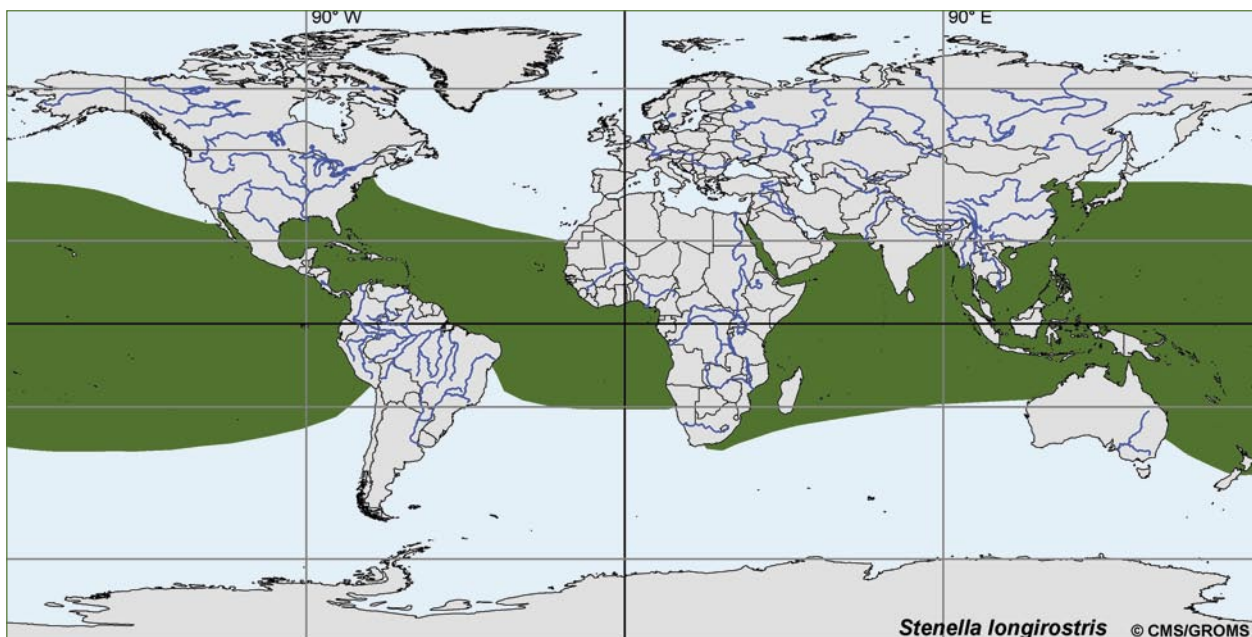


Drawing of *Stenella longirostris* © Wurtz-Artescienza.

### 1. Description

Spinner dolphins can be identified by their relatively long, slender beak, color pattern and fin. Colouration consists of a dark grey cape, light grey lateral field and white ventral field. A dark band runs from the eye to the flipper, bordered above by a thin light line. The rostr-

um is tipped with black or grey. The dorsal fin is basically triangular, slightly falcate to erect. Adults range from 129–235 cm and reach a body mass of 23–78 kg (Perrin, 2002).



Distribution of *Stenella longirostris*. Four different subspecies occur in tropical and subtropical waters in the Atlantic, the Indian and Pacific Oceans: *S. l. longirostris*, *S. l. orientalis*, *S. l. centroamericana* and *S. l. roseiventris* (mod. from Perrin, 1998; Perrin and Gillpatrick, 1994; © CMS/GROMS).

## 2. Distribution

Spinner dolphins are pantropical, occurring in all tropical and subtropical waters around the world between roughly 30-40°N and 20-30°S (Jefferson et al. 1993). The geographical variation in body configuration and colour pattern is more pronounced in spinner dolphins than in any other species of cetacean. Perrin (1990) and Perrin et al. (1999) expressed this variation by naming four subspecies:

*S. l. longirostris*: Occurs mainly around oceanic islands in the tropical Atlantic, Indian, western and central Pacific east to about 145°W. It ranges north to New Jersey, Senegal, the Red Sea, Gulf of Oman, Arabian Sea, Sri Lanka, the Andaman Sea, Gulf of Thailand, southern Honshu, and the Hawaiian Islands (Rice, 1998). Smith et al. (1997a and 1997b) sighted individuals off Myanmar and Vietnam. This subspecies ranges south to Paraná in Brazil, Saint Helena, Cape Province, Timor Sea, Queensland, and Tonga Islands and is vagrant to New Zealand (Rice, 1998).

However, the distribution of *S. l. longirostris* in the Atlantic is very poorly known, especially in South American and African waters; the known range can be expected to expand considerably in those areas with increased attention to the cetacean faunas there. The species is a tropical one, however, and most definitely does not occur in subantarctic waters as indicated previously. The southernmost record is from New Zealand, more than 2000 km south of what is thought to be the normal range but still well north of subantarctic waters (Perrin and Gilpatrick, 1994 and refs. therein). Van Waerebeek et al. (2000) note a lack of recent sightings, strandings or by-catches off West Africa, whereas Ali and Jiddawi (1999) report sightings on the coast of Zanzibar in the Western Indian Ocean.

The many regional populations currently subsumed under the name *S. l. longirostris* differ somewhat in size and other features, and further study may indicate that it would be useful to recognise additional subspecies. It has been claimed that the spinner dolphins in the north-western Indian Ocean are smaller and have a slightly different colour pattern. Perrin (1990) proposed the name "Gray's spinner dolphin" for this race; the "Hawaiian spinner porpoise" is included here. The "Whitebelly spinner porpoise" and the "southern spinner dolphin" are intergrades or hybrids between this race and *S. l. orientalis* (Rice, 1998 and refs. therein).

*S. l. orientalis* Perrin, 1990: Ranges in pelagic waters of the tropical Pacific east of about 145°W, from 24°N off Baja California south to 10°S off Peru, but exclusive of the range of the following race. This is the "eastern spinner dolphin" of Perrin (1990).

Perryman and Westlake (1998) examined lengths of spinner dolphins taken from vertical aerial photographs in the eastern tropical Pacific and found three unique morphotypes. Two of these forms correspond, at least in average length and distribution, to the existing Eastern and Central American subspecies. The third form is intermediate in length between the two recognised subspecies and is found along the edge of the continental shelf north of Cabo Corrientes, Mexico. They provisionally call this form the "Tres Marias spinner dolphin."

*S. l. centroamericana* (Perrin, 1990): This subspecies is found in coastal waters over the continental shelf of the tropical Pacific from the Gulf of Tehuantepec in southern Mexico southeast to Costa Rica. This is the "Central American spinner dolphin" of Perrin (1990).

*S. l. roseiventris* (Wagner, 1846): is distributed in shallow inner waters of Southeast Asia, including the Gulf of Thailand, Timor and Arafura Seas, and similar waters off Indonesia, Malaysia and Northern Australia. It is replaced in deeper and outer waters by the larger pelagic subspecies *S. l. longirostris* (Perrin et al. 1999).

Based on morphological data, van Waerebeek et al. (1999) conclude that Oman spinner dolphins should be treated as a discrete population, morphologically distinct from all known spinner dolphin subspecies. Confirmed coastal range states off the Arabian Peninsula include the United Arab Emirates, the Sultanate of Oman, Yemen, Somalia, Djibouti, Saudi Arabia, Sudan and Egypt.

## 3. Population size

Large numbers have been killed incidentally since the early 1960's by tuna purse seiners in the eastern tropical Pacific (Perrin, 2002): whereas the original population size of the **eastern spinner** dolphin was roughly 1.5 million, the 1979 size reached only 0.3 million (Perrin and Gilpatrick, 1994 and refs. therein).

For the **whitebelly spinner**, the decline in the 60's and 70's was from 0.4-0.5 million to 0.2-0.4 million (Perrin and Gilpatrick, 1994 and refs. therein). Indices for the

following years suggest some increase in abundance. Anganuzzi et al. (1991) confirmed downward trends in the eastern and white-belly stocks possibly extending into the early or mid-1970s but found little change, if any, in more recent years. The **northern whitebelly** spinner stock experienced a notable decline from 1976 to 1980, remaining relatively stable since, with slight indications of increase. However, large fluctuations of unknown origin were observed over the years. Estimates for the **southern whitebelly** stock show little evidence of population changes, although the pattern for this may be approximately the same as that for the northern whitebelly spinner (Reyes, 1991 and refs. therein).

The most recent estimates of absolute population size (Wade and Gerrodette, 1992, in Perrin and Gilpatrick, 1994) are 583,500 for the **eastern spinner** and 992,400 for the **whitebelly spinner**. For the Eastern Tropical Pacific Ocean, Gerrodette (1999) reports a population size of 339,000 eastern spinner dolphins.

Balance and Pitman (1998) conducted a cetacean survey in the pelagic Western Tropical Indian Ocean (WTIO) and report that the cetacean community there was similar to that of the Eastern Tropical Pacific (ETP) and the Gulf of Mexico (GM). Regardless of ocean, three species comprised the majority of cetaceans in the community, *Stenella attenuata*, *S. longirostris*, and *S. coeruleoalba*, representing 62%–82% of all individuals for all species. However, the rank order of abundance for these three species differed with ocean.

Dolar et al. (1997) surveyed marine mammal distribution and abundance and investigated interactions with humans in the southern part of the Sulu Sea and north-eastern Malaysian waters. Population size estimates for spinner dolphins were around 4,000 individuals. For the eastern Sulu Sea, Dolar (1999) estimates abundance at 30,000 eastern spinner dolphins.

#### 4. Biology and Behaviour

**Habitat:** In most tropical waters, nearly all records of spinner dolphins are associated with inshore waters, islands or banks. Around Hawaii spinner dolphins depend on the availability of sheltered shallow bays for use as resting areas during the day. In the eastern tropical Pacific, however, spinner dolphins, like pantropical spotted dolphins, occur in very large numbers on the high seas many hundreds of miles from the nearest land. The spotted dolphin school may serve as

a surrogate "protected bay" for the spinner dolphins to shelter them from predators during their daily quiescent period, thus allowing them to exist and make a living far from land. The habitat there, called by oceanographers "tropical surface water", is typified by unusual conditions of shallow mixed layer, shoal and sharp thermocline, and relatively small annual variation in surface temperature (Reyes, 1991, Perrin and Gilpatrick, 1994 and refs. therein).

The dwarf form of the spinner dolphin in Thai waters apparently inhabits a shallow coral reef habitat (Perrin and Gilpatrick, 1994 and refs. therein).

Davis et al. (1998) characterised the physical habitat of cetaceans found along the continental slope in the north-central and western Gulf of Mexico. *Stenella longirostris* was found over intermediate bottom depths, its distribution overlapping with that of purely pelagic and purely coastal species.

**Schooling:** The spinner dolphin society is composed partly of familial units and more broadly of learned associations beyond the family group. Mother-calf bonds are persistent, as in other dolphins. Social groupings are very fluid, with individuals moving freely among several sets of companions over periods of minutes, hours, days or weeks. Large schools form, break down and re-form with different permutations of subgroups in the course of diurnal inshore-offshore and longshore movements related to nocturnal feeding. It is not known whether or not these broader associations are with members of dispersed kin groups. There is some segregation by age and sex among schools of spinner dolphins in the far-offshore eastern Pacific. It has been suggested that such segregation may be temporary and more pronounced during migration in dolphins. There appears to be no consistent "leader" in a spinner dolphin school. Directional movement appears to be a group process, with direction imparted often from behind, to the sides or below in the school. In a time of stress, the school becomes what has been termed a "sensory integration system" (SIS) and direction may come from anywhere in the school (Perrin and Gilpatrick, 1994, and refs. therein).

In the Eastern Tropical Pacific spinner dolphins are often found in close association with pantropical spotted dolphins, yellowfin tuna and birds of several species and may use spotted-dolphin schools as refugia during diurnal quiescent resting periods; the association varies

in percentage occurrence with time of day (Perrin and Gilpatrick, 1994, and refs. therein).

**Food:** Spinner dolphins feed primarily on small (generally less than 20 cm) mesopelagic fish, squids and sergestid shrimps, diving to at least 200–300 m. In Hawaii, many prey organisms become available to spinner dolphins when the deep scattering layer moves toward the surface at night. Spinner dolphins in the Gulf of Thailand may have an entirely different trophic ecology, feeding on benthic and coral reef organisms (Perrin and Gilpatrick, 1994, and refs. therein).

## 5. Migration

Reilly (1990) found strong seasonal shifts in habitats for the spinner and spotted dolphins but not for common dolphins. There seems to be not only pronounced year-to-year variation in habitat distribution but also sharply definable differences between preferred habitats of eastern and whitebelly spinners, the former were encountered more frequently in regions of relatively sharp thermocline (Perrin and Gilpatrick, 1994 and refs. therein).

Perrin and Gilpatrick (1994, and refs. therein) summarise that in Hawaii, spinner dolphins usually spend the daytime hours resting in shallow bays near deep water. They move offshore at dusk to feed. During feeding, they may move some distance along the shore, so the same animals may not be present in the same bay on two successive days. Not all animals go into the rest coves every day; some move slowly along the shore between successive nights. Maximum net movement observed was 113 km over 1,220 days. Marten and Psarakos (1999) report on the strong site-fidelity in Hawaiian animals. At least one and up to three animals were re-sighted north-west of Oahu 20 years after the first reported sighting.

Spinner dolphins at Fernando de Noronha Island off northern Brazil exhibit daily movements similar to those observed in Hawaii. Seven tagged spinner dolphins in the eastern tropical Pacific moved minimum distances of 12 to 275 nautical miles (within 16h and 365 days, respectively). Maximum time at liberty was 776 days (minimum distance travelled 172 nautical miles). The number of tag returns (seven of 340) was insufficient to allow detection of a migratory pattern if one exists. Minimum distances moved were less than for pantropical spotted dolphins at liberty for similar periods of time; the spinner dolphin may be less migratory (Perrin and Gilpatrick, 1994, and refs. therein).

Norris et al. (1994) summarise that spinner dolphin distribution and abundance is related to certain local oceanographic phenomena. For example, divergence zones at current margins and current ridges both concentrate food organisms and are heavily frequented by dolphins of various species, including spinners. Whereas one scientific view suggests that populations remain geographically stable over rough bottom topography, another view suggests that at least some populations may move widely without reference to the bottom. Where a warm current swings away from the tropics along an ocean margin—for example where the Kuroshiro current moves northward along the eastern shore of Japan—oceanic dolphin populations, including the spinner dolphin, migrate in such water masses and move considerable distances.

## 6. Threats

**Directed fisheries:** Small numbers of spinner dolphins are taken in localised harpoon fisheries in many places around the world, e.g. the Lesser Antilles, the Philippines, and Indonesia. They were formerly taken in small numbers in drive fisheries in Japan. 117 by-caught spinner dolphins were landed in India in 1986–87, presumably for human consumption. Dolphins taken incidentally in Venezuela are utilised for shark bait and human consumption (Dolar et al. 1994; Perrin and Gilpatrick, 1994 and refs. therein).

Ilankoon (1997) reports on the interaction between small cetaceans and the fisheries industry in Sri Lanka. He found *Stenella longirostris* to be the most abundantly caught species at all investigated sites. The post-monsoonal period from the end of August to November was the season when peak catches were recorded. Deliberate harpooning was found to account for a sizeable proportion of the small cetacean catch while the practice itself seems to be spreading to new areas.

**By-catches:** Both the whitebelly and eastern spinner forms have been heavily involved in the tropical Pacific tuna purse seine fishery. The numbers of eastern spinners have been reduced significantly in the last few decades by this fishing practice. Wade (1995) estimated that between 1959 and 1972 by-catch totalled 1.3 million individuals (91,739 per year). Recent reports by Hall (2001) and Bratten and Hall (1997) illustrate the measures taken to reduce by-catch. Levels today are 0 (US vessels) and ca. 3,000 dolphins (all species) for non-US vessels fishing for tuna (Gosliner, 1999).

Gerrrodette (2002) however, states that by 1999, there was no clear indication of a recovery for eastern spinner dolphins. Several factors could be responsible for this:

- cryptic effects of repeated chase and encirclement on survival an/or reproduction (internal injuries, stress, hyperthermia), separation of nursing calves from their mothers during the fishing process. Indeed, Archer et al. (2001) report a calf deficit in the number of lactating spinner dolphin females being killed between 1973 and 1990. These unobserved deaths of nursing calves due to separation from their mothers during fishing indicate that the reported dolphin kill fails to measure the full impact of purse-seine fishing on spotted dolphin populations.
- unobserved or observed but unreported adult mortality,
- effects due to breakup of dolphin schools (increased predation, social disruption),
- ecological effects due to removing tuna from the tuna-dolphin association, and
- ecosystem or environmental changes. See also species account for *S. attenuata* (page 276).

Significant catches of spinner dolphins also occur in the Caribbean, Australia, Japan, the Philippines, and Sri Lanka; in this last area up to 15,000 are killed each year in gillnets and by hand-harpooning. There are likely to be fisheries interactions off West Africa (Jefferson et al. 1993; Perrin and Gilpatrick, 1994; Carwardine, 1995). A trawl shrimp fishery in the Gulf of Thailand takes a yet unknown number of *S. l. Roseiventris* (Reyes, 1991). Zerbini and Kotas (1998) report on by-catches in Brazilian drift-net fisheries and Cockroft (1990) on animals entangled in shark nets off Natal.

**Pollution:** Relatively high levels of mercury and contamination with DDT, Dieldrin and PCBs have been reported for the species (Tanabe et al. 1993). The high level of Hg has been attributed to natural sources, but in the case of DDT and PCBs the agricultural and industrial development in Central America may be the cause (Velayutham et al. 1994; Velayutham and Venkataramanujam 1995; Perrin and Gilpatrick, 1994 and refs. therein; Reyes, 1991).

**Tourism:** Tourist development may affect the habitat of some spinner dolphin populations, for example,

at Fernando de Noronha Island, Brazil (Reyes, 1991). However, Ali and Jiddawi (1999) report that in Zanzibar the touristic value of *S. longirostris* far exceeded that of using them as bait for sharks. As many as 2,000 tourists visit the dolphin site at Kizimkazi per month. Successful management of the dolphin-tourist trade will ensure continued visitors to the villages where dolphins are present and thus add income to these villages while contributing to management and conservation.

## 7. Remarks

The eastern tropical Pacific populations and south-eastern Asian populations of *Stenella longirostris* are listed in Appendix II of CMS. The species is listed as "Lower Risk, conservation dependent" by the IUCN.

Range States include Colombia, Costa Rica, Ecuador, El Salvador, France (Clipperton Islands), Guatemala, Honduras, Mexico, the Netherlands, Nicaragua, Panama, Peru, Portugal (Azores), Spain, the United States and Vanuatu, as well as all other maritime nations with tropical or semi-tropical waters. Co-operative research should be continued in order to reduce the incidental mortality and to identify potential sources of habitat degradation, such as pollution and tourist development (Reyes, 1991). Spinner dolphins also occur in South America, so please see Huckle-Gaete (2000) in Appendix 1 for further recommendations. See also general recommendations on Southeast Asian stocks in Perrin et al. (1996) in Appendix 2.

In a recent article on small cetaceans at risk, including the spinner dolphin, Perrin (1999) listed the special problems faced by small cetaceans in general:

- ease of capture,
- vulnerable habitats,
- development of new markets (incidental catches are marketed, see examples above (directed fisheries), and the demand causes more deliberate catches),
- difficulties in monitoring and regulation of incidental kills,
- lack of international management (small cetaceans fall outside the IWC).

Finally "Effective conservation requires meaningful national laws and the will and resources to enforce them, recognition and management of incidental mortality within sustainable limits, continued attention by non-governmental groups, and greater efforts to

make the public in the less-well developed countries aware of the value and vulnerability of their dolphins, porpoises, and small whales" (Perrin, 1999).

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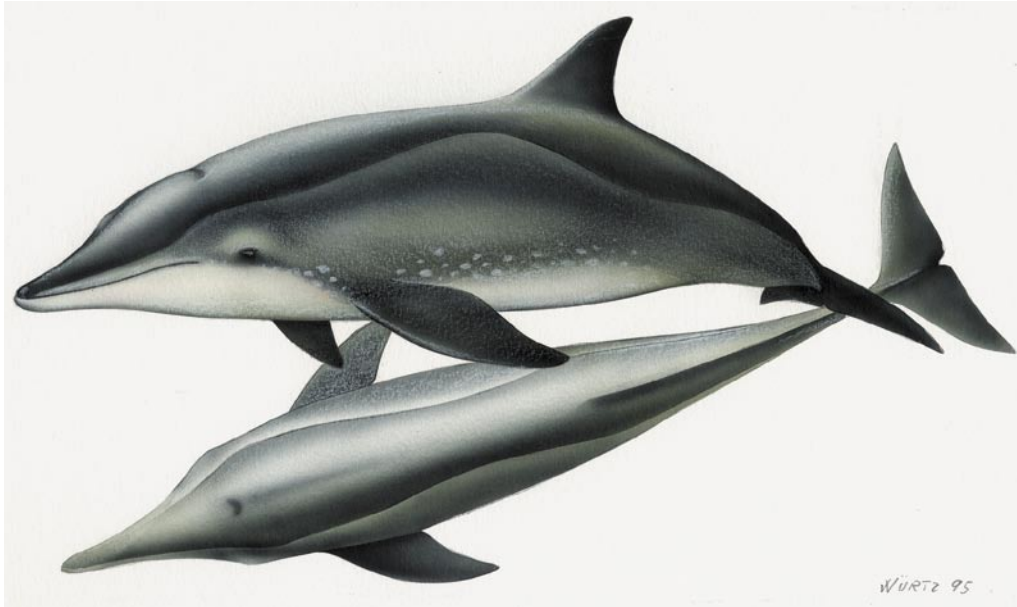
## 5.67 *Steno bredanensis* (G. Cuvier in Lesson, 1828)

English: Rough-toothed dolphin

German: Rauzahndelphin

Spanish: Delfin de dientes rugosas

French: Steno

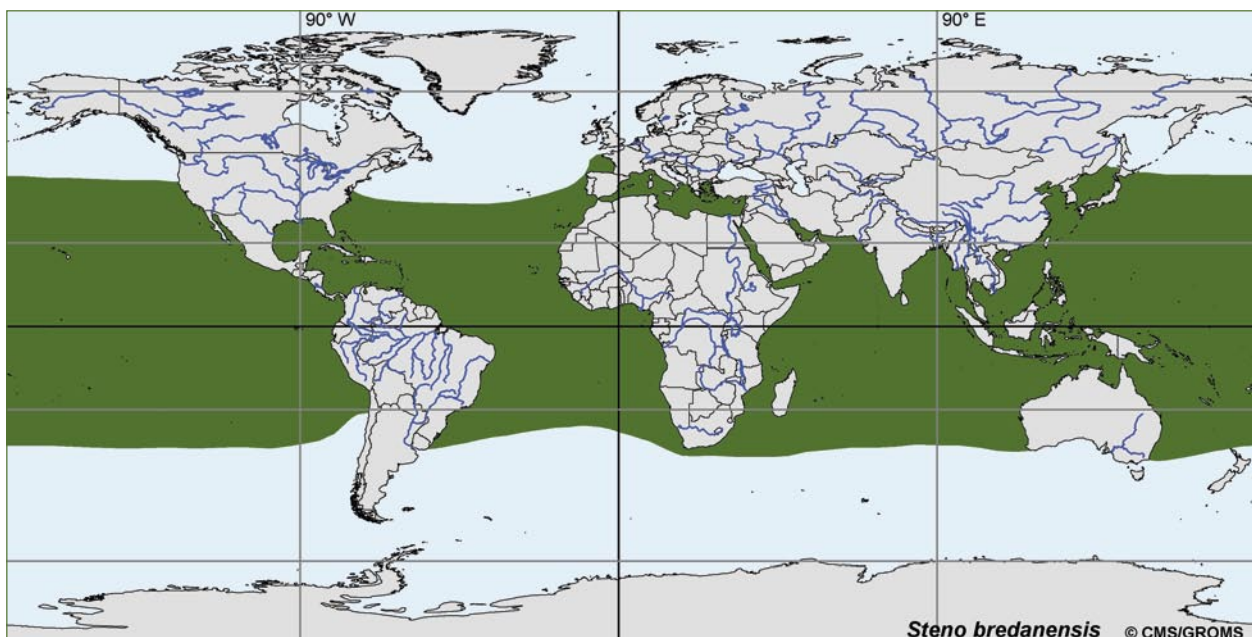


Drawing of *Steno bredanensis* © Wurtz-Artescienza.

### 1. Description

This is the only long-beaked dolphin with a smoothly sloping melon that gently blends into the upper beak. The body is not very slender and the anterior may be stocky. The large flippers are set further back on the body than in most other cetaceans. The dorsal fin is tall and only slightly recurved. Some large males may have a hump posterior to the anus resembling a keel. Rough

dolphins are countershaded with white bellies and black to dark grey backs. The sides are medium grey and separated from the back by a cape. Size reaches 265 cm and body mass may reach 155 kg (Jefferson, 2002).



Distribution of *Steno bredanensis*: deep tropical, subtropical and warm temperate waters around the world (mod. from Jefferson, 2002; Carwardine, 1995; © CMS/GROMS).

According to Maignet (1995) *Steno bredanensis* is a species with high morphological variability. Some differences between Atlantic and Pacific specimens have been recorded, especially with respect to rostrum length. These differences may or may not be within the typical range for the species.

## 2. Distribution

*S. bredanensis* is distributed in tropical and warm temperate waters around the world. It ranges north to the Gulf of Mexico, Virginia, the Netherlands, Mediterranean Sea, Gulf of Aden, Arabian Sea, Bay of Bengal, East China Sea, Pacific coast of central Honshu, Hawaiian Islands, and Baja California Sur (Rice, 1998). Its southern range extends to Rio Grande do Sul in Brazil, about 32°S in the eastern Atlantic, Natal, Timor Sea, Coral Sea, New Zealand, and Botija (24°30'S) in northern Chile (Rice, 1998). Monteiro et al. (2000) and Ott and Danilewicz (1996) confirm a few sightings as by-catches of *Steno bredanensis* off Brazil. Vagrant north to Oregon and Washington (Ferrero et al. 1994; Rice, 1998).

According to Carwardine (1995) the distribution of *Steno bredanensis* is poorly known, and the map is based on relatively few sightings spread over a wide area. The species does not appear to be particularly numerous anywhere, although researchers have worked mostly in the eastern tropical Pacific and may simply have missed areas of high abundance elsewhere. There have been many more sightings in recent years, especially around Hawaii; and a number of recent sightings off the coast of Brazil suggest a more southerly distribution in the Atlantic. There appears to be a permanent population in the Mediterranean.

## 3. Population size

An estimated 151,100 rough-toothed dolphins inhabit the eastern tropical Pacific. During a number of survey cruises conducted in the region over a period of approximately 20 years, 176 of 4,006 schools of small cetaceans seen were of rough-toothed dolphins; the species was encountered less often than *Stenella attenuata*, *S. longirostris*, *S. coeruleoalba*, *Delphinus delphis*, *Globicephala macrorhynchus*, *Grampus griseus*, and *Tursiops truncatus* but more often than *Peponocephala electra*, *Orcinus orca*, *Pseudorca crassidens*, *Feresa attenuata*, *Kogia* spp. and beaked whales. However, this ranking could be affected by relative sightability as well as by abundance (Miyazaki and Perrin, 1994 and refs. therein).

## 4. Biology and Behaviour

**Habitat:** Most often *Steno bredanensis* is found in deep water far offshore, usually beyond the continental shelf (Maignet, 1995). Off the Canary Island of La Gomera, *S. bredanensis* was found in waters of 506 m mean depth, but mean distance from shore was only 4.4 km (Ritter, 2002). Rough-toothed dolphins appear to be widespread in warm waters around the world, normally where sea surface temperature is above 25°C and seem to avoid cold surface waters and cold currents (Carwardine, 1995). However Ritter (2002) reports that the year-round abundance off La Gomera, Canary Islands, indicates that this species might endure temperatures well below 25°C.

**Behaviour:** *Steno bredanensis* is a fast swimmer, sometimes porpoising with low, arc-shaped leaps. It may swim rapidly just under the surface, with dorsal fin and a small part of the back clearly visible. Sometimes it bow-rides, especially in front of fast-moving vessels, though not as readily as many other tropical dolphins. *Steno* may associate with Bottlenose Dolphins and pilot whales and, less frequently, with spinner dolphins and spotted dolphins, and sometimes with shoals of Yellowfin Tuna (Carwardine, 1995; Miyazaki and Perrin, 1994).

**Schooling:** Schools of up to 50 animals have been reported in the eastern tropical Pacific and central Atlantic (Ritter, 2002) but smaller groups of 10–20 seem more usual. Five schools in Japanese waters contained from 23 to 53 animals. However, these small schools may be parts of larger, dispersed aggregations; one such aggregation of "schools" observed from the air off Hawaii contained an estimated 300 dolphins and another seen in the Mediterranean contained approximately 160 animals in eight groups of about 20 each (Miyazaki and Perrin, 1994 and references therein).

**Food:** The diet in the wild includes fish and squid. Cephalopods reported from stomach contents include *Teuthowenia* sp. and *Tremoctopus violaceus*. The alga *Sargassum filipendula* was found in the stomachs of several stranded animals; the significance of this is unknown. The stomachs of animals stranded in Hawaii contained the atherinid *Pranesus insularum*, the scomberesocid *Cololabis adocetus*, the belonid *Tylosurus crocodilus*, all nearshore species, and squid. Other, larger fish may be taken in deeper water. Cooperative food gathering has been reported (Miyazaki and Perrin, 1994 and refs. therein). Maximum reported

dive depth was 70 m, but they may dive deeper. Maximum dive duration was 15 min (Jefferson, 2002).

## 5. Migration

The species is difficult to observe at sea: schools are extremely difficult to follow, staying submerged for as long as 15 min (Miyazaki and Perrin, 1994).

Because rough-toothed dolphins seem to prefer warmer waters, it may be hypothesised that the species follows warm currents. It is assumed that the range of *Steno* does not extend beyond the 35th parallel. However, there are no detailed reports on movements and seasonal migrations (Maigret, 1995).

## 6. Threats

**Mass strandings:** Miyazaki and Perrin (1994 and references therein) summarise that mass stranding may reduce population size. A school of 17 stranded in Hawaii in 1976. Further mass strandings have been summarised by Maigret (1995). The reasons for such mass strandings are, to date, poorly understood. A possible cause is disorientation, caused by parasites affecting the inner ear, by damage due to military sonar or geological prospection, or by variability in the earth's magnetic field, coupled with altruistic behaviour, herd members not abandoning one another.

In the past 6 years IMMRAC (the Israeli Marine Mammal Research and Assistance Center) has examined 7 strandings of rough-toothed dolphins along the entire Mediterranean Israeli coastline. The species is considered rare in the Mediterranean, and this regional clustering seems rather unusual. It is interesting to notice that all strandings have occurred between the months of February – April: presumably during a seasonal migration (Aviad Scheinin, pers. comm.).

**Directed fisheries:** Small numbers are taken in drive fisheries at Okinawa in the Ryukyus and in the home islands of Japan, the Solomon Islands and Papua New Guinea and by harpoon in Japan, at St Vincent in the Lesser Antilles and in West Africa and possibly formerly were taken at St Helena in the South Atlantic. However, only 23 rough-toothed dolphins were captured in Japan (Okinawa) during the period 1976-81 (Miyazaki and Perrin, 1994 and refs. therein).

**By-catches:** A few rough-toothed dolphins are killed incidentally in tuna purse seines in the eastern tropical Pacific: 21 were estimated killed during the period

1971–75 and 36 died in a single net haul in 1982. Small numbers are also taken as by-catch in gillnet and driftnet fisheries in Sri Lanka, Brazil, the Central North Pacific and probably elsewhere around the world in tropical and warm-temperate waters (Miyazaki and Perrin, 1994 and references therein).

Monteiro et al. (2000) report on fishery-related mortality along the coast of Ceara state, Northeast Brazil, commenting on the possible conservation implications for the local populations. From January 1992 to December 1998, a total of 13 *S. bredanensis* strandings occurred along the coast. Most animals were recovered at state geographic zones II and III where finfish fisheries and stranding survey efforts were highest. Seasonally, incidental catches were more frequent during the austral spring (October–December). The small number of individuals in conjunction with long gestation and nursing periods, suggest that an increased mortality due to dolphin-fisheries interactions could severely impact local populations of both species.

**Pollution:** Levels of PCBs and DDE in the blubber of two specimens collected in the western Pacific were lower by two orders of magnitude than those recorded in *Stenella coeruleoalba* and other delphinids (Miyazaki and Perrin, 1994 and refs. therein). Marsili and Focardi (1997) report on chlorinated hydrocarbon concentrations in specimens from the Mediterranean Sea.

## 7. Remarks

*Steno bredanensis* has a large distributional range and is known from by-catch in several countries. The biology, life history, population size, and separation into sub-species as well as migratory behaviour are insufficiently known. Research on this species should be encouraged. See also recommendations on South American stocks in Hucke-Gaete (2000) in Appendix 1 and recommendations on Southeast Asian stocks in Perrin et al. (1996) in Appendix 2.

IUCN Status: "Data Deficient". Not listed by CMS.

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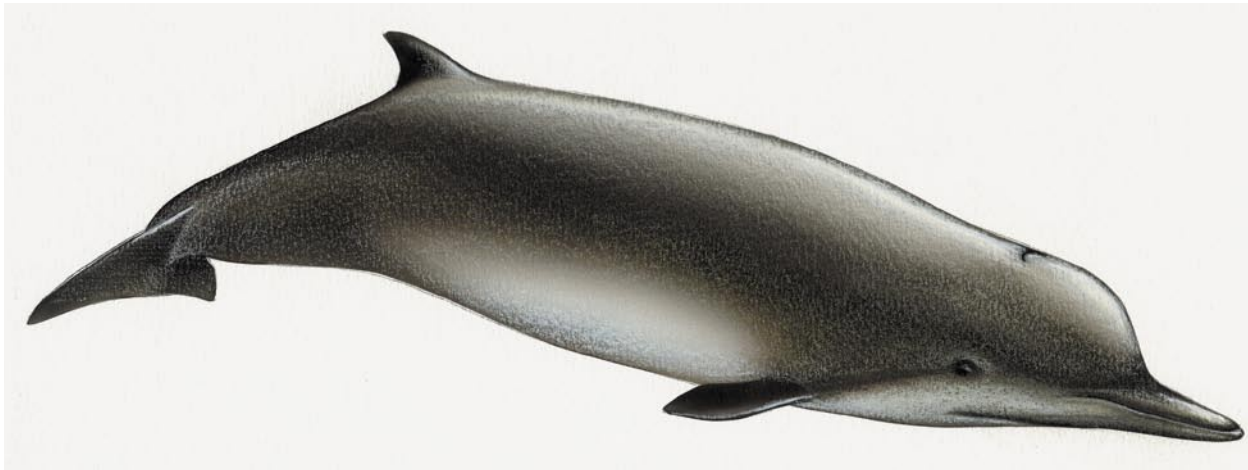
## 5.68 *Tasmacetus shepherdii* (Oliver, 1937)

English: Tasman beaked whale

German: Shepherdwal

Spanish: Ballena picuda de Shepherd

French: Tasmacète



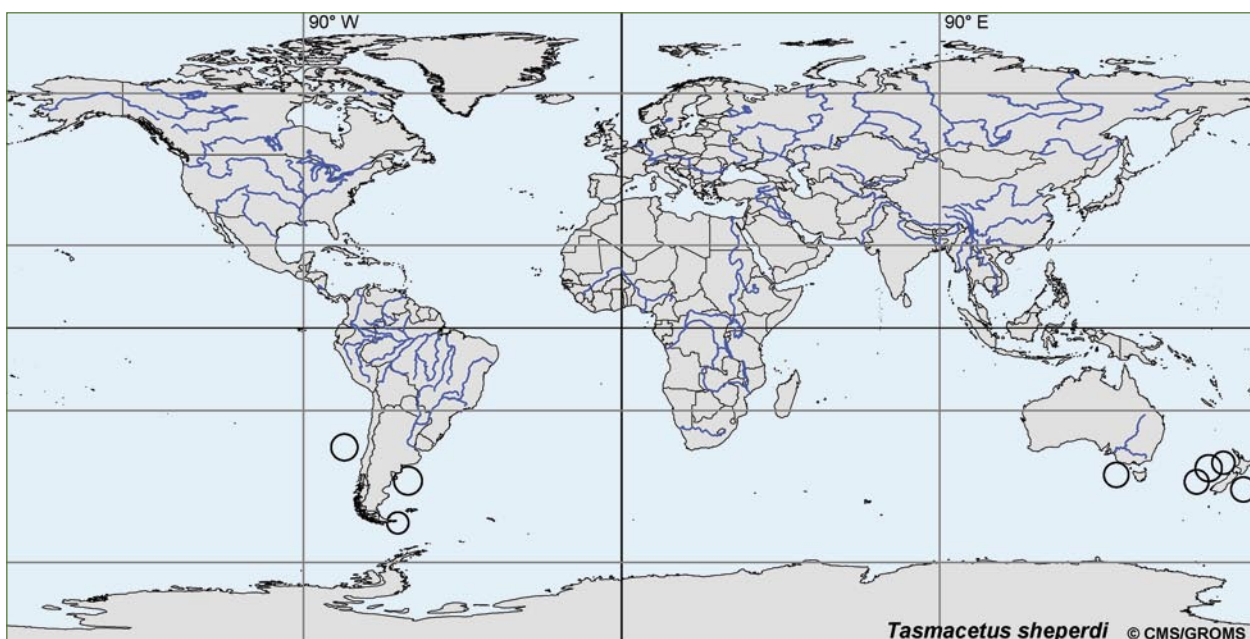
Drawing of *Tasmacetus shepherdii*  
© Wurtz-Artescienza.

### 1. Description

*Tasmacetus shepherdii* is a rare animal, known from only 21 strandings in the southern hemisphere. Adults are between 6 and 7 m long and have a full set of functional teeth, as opposed to all other beaked whale species. Colouring is dark grey dorsally with a white ventral field extending towards the back on both anterior and posterior sides of the flippers (Mead, 2002).

### 2. Distribution

Tasman's beaked whale is probably circumglobal in temperate waters of the Southern Hemisphere, but specimens have been collected only in: Tierra del Fuego and Peninsula Valdez in Argentina, Tristan da Cunha; South Africa; Port McDonnell in South Australia, North Island, South Island, Stewart Island, and Chatham Island in New Zealand, and Isla Mas Afuera in the Islas Juan Fernández (Rice, 1998).



Distribution of *Tasmacetus shepherdii*: cold temperate waters of the southern hemisphere, predominantly New Zealand (mod. from Carwardine, 1995; Mead, 2002; © CMS/GROMS).

Putative sightings of live individuals were reported from the western South Atlantic (53°45'S, 42°30'W) and off Christchurch on the east coast of South Island, New Zealand (Rice, 1998).

### 3. Population size

Nothing is known about the relative abundance of this species or its population composition. It is suspected, based on the lack of identified sightings, that all ziphiids except *Berardius* and *Hyperoodon*, have relatively small populations. This could also be due to their naturally cryptic habits (Mead, 1989).

### 4. Biology and Behaviour

**Habitat:** Probably lives mainly far offshore, well away from coasts; however, where there is a narrow continental shelf, *Tasmacetus shepherdi* may sometimes occur in deep water close to shore (Carwardine, 1995).

**Behaviour:** Very little is known of the natural history of this species. All of the confirmed records are at least partially decomposed strandings. There are only 2 possible sighting records (Jefferson et al. 1993).

**Food:** They are known to feed on several species of fish, possibly near the bottom in deep waters (Jefferson et al. 1993). This fish diet is reflected by a fully functional set of teeth as opposed to the other ziphiids which mainly live on squid (Carwardine, 1995).

### 5. Migration

Six of the strandings have occurred in the southern summer (November-March) and one has occurred in the winter (August). This is too small a sample on which to base conclusions on seasonal distribution (Mead, 1989).

### 6. Threats

There are no records of human exploitation (Jefferson et al. 1993).

### 7. Remarks

Very little is known about this species. Tasman's beaked whale is listed by the IUCN as "Data Deficient" and not listed by CMS. More information is clearly needed.

*T. shepherdi* also occurs in southern South America, therefore the recommendations iterated by the scientific committee of CMS for small cetaceans in that area (Hucke-Gaete, 2000 in Appendix 1) also apply.

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## 5.69 *Tursiops aduncus* (Ehrenberg, 1833)

English: Indian Ocean bottlenose dolphin

German: Grosser Tümmler des Indischen Ozeans

Spanish: Delfin mular del Oceano Indico

French: Grand dauphin de l'océan Indien

### 1. Description

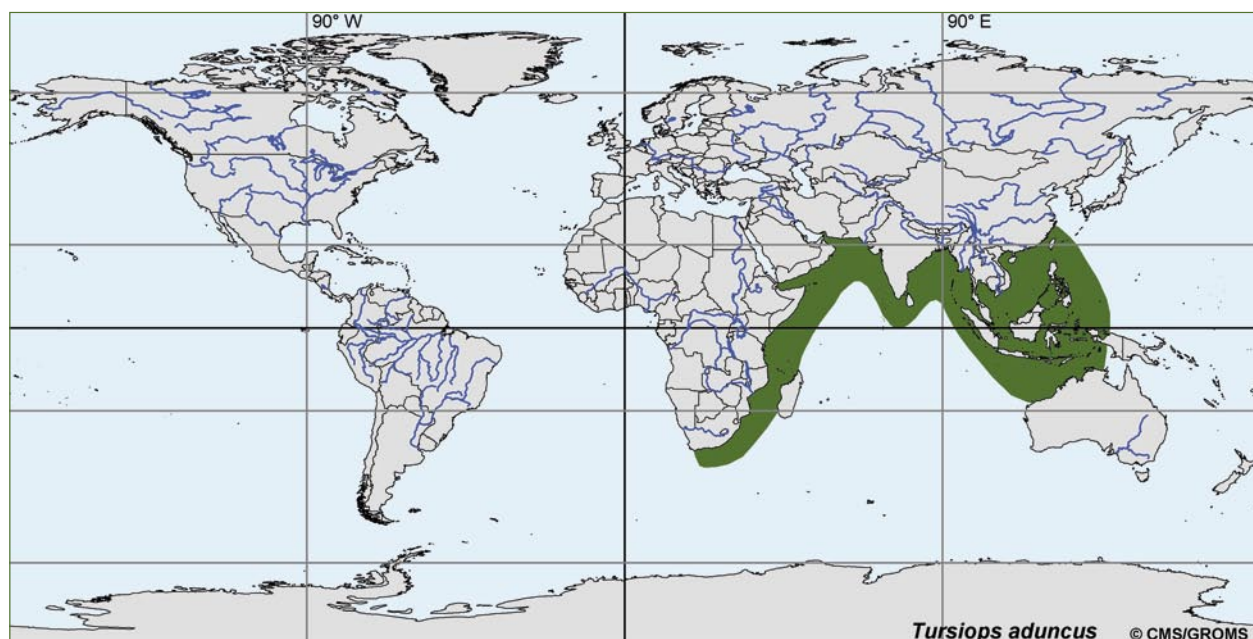
*T. aduncus* tends to be smaller than *T. truncatus* (see page 315), has a proportionately longer rostrum and develops ventral spotting at about the time of sexual maturity (Wells and Scott, 2002).

For Chinese waters, Wang et al. (1999) confirm that two distinct morphotypes of bottlenose dolphins, which have been referred to as *T. truncatus* and *T. aduncus*, exist in sympatry. Comparisons of a 386-bp fragment of the mitochondrial DNA (mtDNA) control region (n=47) indicate that the two sympatric morphotypes are genetically distinct. Phylogenetic analyses show that the *truncatus*-type dolphins from Chinese waters are more closely related to Atlantic Ocean *truncatus*-type than to the sympatric *aduncus*-type dolphins. These molecular data agree completely with morphological classifications of the specimens. This congruence is strong evidence that the sympatric morphotypes in Chinese waters are reproductively isolated and comprise two distinct species, with important

implications for the conservation of bottlenose dolphins in Chinese waters.

New results may justify further subdivisions of *Tursiops* species in the near future: Curry (1997) used 127 mitochondrial DNA control region sequences to investigate intra- and interspecific differences among bottlenose dolphins. She identified 73 haplotypes and the results, combined with information on morphology and ecology, supported the suggestion that there are species-level differences between inshore and offshore bottlenose dolphins in the western North Atlantic /Gulf of Mexico.

Recent genetic evidence suggests that *T. aduncus* is more closely related to pelagic *Stenella* and *Delphinus* species, and in particular to *S. frontalis*, than to *T. truncatus*. Should these findings be confirmed, they would have more than just taxonomic implications and greatly influence segregations based on morphology and social behaviour (Wells and Scott, 2002).



Distribution of *Tursiops aduncus*: coastal waters of the Indian and Western Pacific Oceans, along the entire coast of Africa, through the Red Sea and Persian Gulf, eastwards as far as Taiwan and south-eastward to the coastal waters of Australia (Wells and Scott, 2002; © CMS/GROMS).

## 2. Distribution

Investigations by Curry (1997) indicate the separation of *Tursiops aduncus* and *Tursiops truncatus* into two clades: *Tursiops aduncus* ranges along the coast of eastern Africa from Cape Province north to the Red Sea, thence eastward through the Persian Gulf, Arabian Sea, and Bay of Bengal, as far as Taiwan, thence south-east to northern Australia. Möller and Beheregaray (2001) found that coastal *Tursiops* off south-eastern Australia also belonged to the *aduncus* type.

Dolphins from Amami Gunto, between Kyushu and the Ryukyus, also agree with *aduncus* in their spotted underparts and other features. Dolphins from the Hawaiian Islands lack the ventral spotting, as do all but a few old females from the eastern tropical Pacific between southern California and Peru (Rice, 1998 and refs. therein; cf. also Curry, 1997).

## 3. Population size

Marked geographic variation among bottlenose dolphins—in particular, morphological variation between inshore and offshore animals—has contributed to uncertainties regarding stock structure and taxonomy within the genus. Stock delineations are necessary to assess the impacts of die-off and fishery mortalities on bottlenose stocks, and to conserve population units (Curry, 1997).

## 4. Biology and Behaviour

no entries.

## 5. Migration

no entries.

## 6. Threats

no entries.

## 7. Remarks

Clearly, more research is needed in order to establish the range and importance of different species, subspecies and their populations of the genus *Tursiops*, as well as basic biological information related to population size, behavioural differences and isolation, and migratory patterns.

Populations of *Tursiops aduncus* in the Arafura / Timor Sea are listed in Appendix II of CMS. The species is not listed by the IUCN. For general remarks on south-east asian species, see Perrin et al. (1996).

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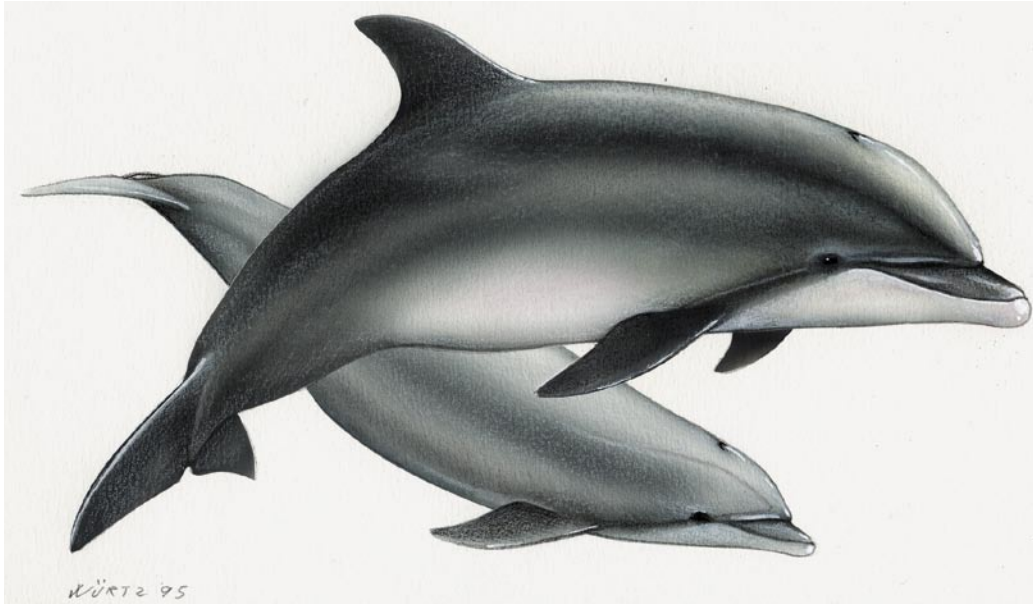
## 5.70 *Tursiops truncatus* (Montagu, 1821)

English: Bottlenose dolphin

German: Grosser Tümmler

Spanish: Delfin mular

French: Grand dauphin



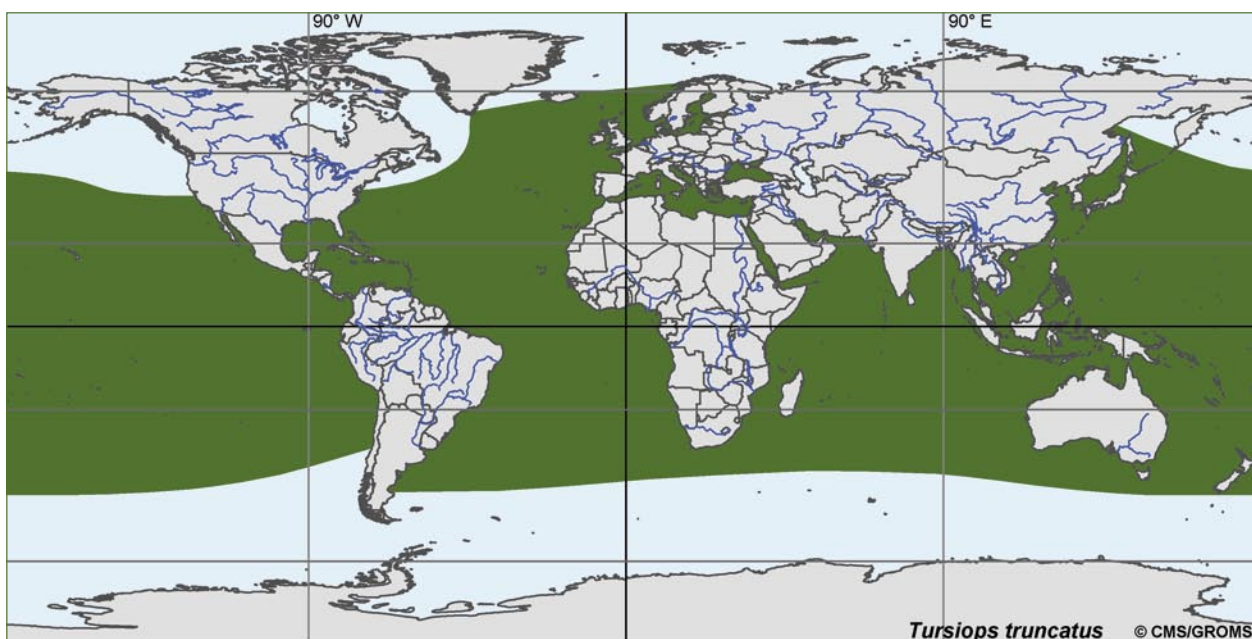
Drawing of *Tursiops truncatus* © Wurtz-Artescienza.

### 1. Description

Bottlenose dolphins are recognized by their medium-sized, robust body, moderately curved dorsal fin, and dark coloration, with a sharp demarcation between the melon and the short rostrum. Adult lengths range from 2–3.8 m, weights from 220–500 kg (mean of 242 kg), varying geographically. Body size also seems to vary inversely with water temperature in many parts of the

world. The animals are coloured light grey to black dorsally, with a light belly (Bloch and Mikkelsen, 2000; Wells and Scott, 2002).

Despite the wide distribution, abundance, and popularity of bottlenose dolphins, their taxonomy remained muddled for a long time (Rice, 1998).



Distribution of *Tursiops truncatus*: widely distributed in cold temperate to tropical seas worldwide (map mod. from Wells and Scott, 2002; © CMS/GROMS).

Geographical variation in bottlenose dolphins is only vaguely comprehended, and in most parts of the world subspecific designations are best avoided. The name *T. t. truncatus* (type locality: Great Britain) may be applied to the offshore populations on both sides of the North Atlantic, and some authors have used it for similar animals that live in the temperate waters of the western North Pacific, South Africa, Walters Shoal, southern Australia, and New Zealand. Often, there are size differences between neighbouring populations: The dolphins that live in the Black Sea (named *T. t. ponticus* Barabash-Nikiforov, 1940) are smaller than those in the North Atlantic, while those in the Mediterranean are intermediate in size. In some parts of the world, sharply differentiated inshore and offshore populations live in close proximity. Results of mtDNA analyses do not indicate genetic isolation among offshore populations from different ocean basins, but do show that there are differing coastal or inshore populations which are genetically isolated from offshore populations (Rice, 1998 and refs. therein).

Recent genetic work by Le Duc et al. (1999), osteological comparisons by Wang et al. (2000) and morphological analyses by Hale et al. (2000) support the view that bottlenose dolphins of the tropical Indian Ocean, *T. aduncus*, are reproductively isolated from the widespread *T. truncatus*.

## 2. Distribution

In the Atlantic *T. truncatus* occurs north to the Gulf of Mexico, George's Bank off Massachusetts, the Azores, the British Isles, The Faroe Islands, the Baltic Sea including the Gulf of Finland, the Mediterranean and Black seas. In the Pacific it ranges north to the Bo Hai (Gulf of Chihli), East China Sea, central Honshu, Kure Atoll, Hawaii, Isla Guadalupe, and Monterey Bay in California. In the Southern Hemisphere *T. truncatus* occurs south to Golfo San Matias in Argentina, 18°S in northern Namibia, Port Elizabeth in Cape Province, Walters Shoal (33°20'S, 43°30'E) in the south-western Indian Ocean, the southern coast of Australia including Tasmania, South Island in New Zealand, and Concepción, Chile (Rice, 1998). Recent evidence (Möller and Beheregaray, 2001), however, suggests that coastal *Tursiops* off south-eastern Australia belong to the *aduncus* type.

Bottlenose dolphins are found primarily in coastal and inshore regions of tropical and temperate waters of the world, and population density seems to be higher near-

shore. There are also pelagic populations, such as those in the eastern tropical Pacific and around the Faroe Islands. Except for their occurrence around the United Kingdom and northern Europe, they generally do not range poleward of 45° in either hemisphere (Jefferson et al. 1993). The bottlenose dolphins occurring around the Faroe Islands (62°N 7°W) seem to be the most northerly of the North Atlantic offshore populations (Bloch and Mikkelsen, 2000).

In the North Atlantic, *Tursiops truncatus* is vagrant to Newfoundland and Norway, and in the North Pacific it ranges as far north as Puget Sound in Washington State (Rice, 1998). The species is rare in the Baltic Sea, and there is some question as to their occurrence in the Barents Sea (Wells and Scott, 1999 and refs. therein)

Sykes et al. (2003) investigated the variables that best predict the seasonal distribution of sightings of Bottlenose dolphins along the Dorset coast (England). The factors investigated included salinity, sea surface temperature, chlorophyll a (an indicator of primary productivity) and fish distribution (inferred from landing catch data). Local data sampling validated the use of historical data sets for all the variables. They found that chlorophyll a and fish distribution were the main factors influencing Bottlenose dolphin distribution. Of the 29 fish species investigated, Brill ( $P < 0.005$ ), Cuttlefish ( $P < 0.0001$ ), Plaice ( $P < 0.0001$ ), Pollack ( $P < 0.005$ ), Red and Grey Mullet ( $P < 0.005$ ), Sole ( $P < 0.001$ ), Sprat ( $P < 0.0001$ ) and Spurdog ( $P < 0.0001$ ) were found to be significant predictors and could explain 88% of the frequency of dolphin sightings. Stepwise Multiple Regression also identified historical chlorophyll a ( $P < 0.05$ ) as a significant predictor of sightings, explaining 13.5% of the frequency of dolphin sightings. These findings indicate that feeding is an important factor affecting Bottlenose dolphin distribution along the Dorset coast.

## 3. Population size

Only a few abundance estimates are available for *Tursiops* from parts of the species' range. In the northern Gulf of Mexico, the population estimate ranges from 35,000–45,000 *Tursiops* inshore of the 100-fathom contour, an area that extends to more than 250 km from shore. Off the northeast coast of North America, the overall population is approximately 10,000–13,000, of which the inshore form comprises around 4%. Large-scale research vessel surveys by the US National Marine Fisheries Service (NMFS) produced an estimate of 243,500 *Tursiops* in the eastern tropical

Pacific. Japanese surveys found 316,935 dolphins in the Northwest Pacific.

Reports for various areas, such as the Mediterranean, identify *T. truncatus* as the most common and abundant dolphin, but estimates of population size are not given. A Russian survey of the Black Sea estimated a population size of 7,000 *Tursiops*, although the details of the surveys were not presented. Approximately 900 bottlenose dolphins inhabit the 400 km stretch of coastal waters off Natal, south-east of southern Africa (Wells and Scott, 1999 and refs. therein; Reyes, 1991 and refs. therein). In the eastern Sulu Sea, Dolar (1999) estimated the population size at 2,200.

From the North Atlantic Sightings Surveys in 1987 and 1987 (NASS-87 and NASS-89) a very cautious estimate of the bottlenose dolphins around the Faroe Islands comes to about 1,000 animals (Sigurjónsson et al. 1989; Sigurjónsson and Gunnlaugsson, 1990; Bloch and Mikkelsen, 2000).

#### 4. Biology and Behaviour

**Habitat:** As a result of increased pelagic survey efforts over the last 20 years, researchers have come to recognise *Tursiops* as a truly cosmopolitan species. Although they tend to be primarily coastal, they can also be found in pelagic waters (Wells and Scott, 1999). Bottlenose dolphins exploit a wide variety of habitats. The inshore form frequents river mouths, bays, lagoons and other shallow coastal regions (between 0.5–20 m). Occasionally they may travel far up into rivers.

The offshore form is apparently less restricted in range and movement, and can be found in many productive areas, particularly in the tropics. Some offshore populations are residents around oceanic islands. A coastal habitat seems to be preferred in the Black Sea, with limited movements into offshore waters (Reyes, 1991 and refs. therein). Limits to the species' range appear to be temperature related, either directly, or indirectly through distribution of prey. Off the coasts of North America, they tend to inhabit waters with surface temperatures ranging from about 10°C to 32°C (Wells and Scott, 1999 and refs. therein).

**Food:** The differences between inshore and offshore *Tursiops* are also reflected in their feeding habits. The inshore form feeds primarily on a variety of fish and invertebrates from both the littoral and sub-littoral zones, whereas mesopelagic fish and oceanic squids

are commonly reported as the diet of animals of the offshore form (Reyes, 1991 and refs. therein).

Diet also varies with local prey availability. Along the central US Atlantic coast 31 genera of fish and two species of invertebrates were reported from stomach samples. The four most common prey items were fish: *Cynoscion regalis*, *Micropogonias undulatus*, *Leiostomus xanthurus*, and *Bairdiella chrysoura*. Stomach contents of dolphins caught off South Africa were composed of at least 50 genera of fish and at least three genera of cephalopods. The most important prey included fish: *Trachurus delagoae*, *Pomadasys olivaceum*, *Pagellus bellotti*, and *Scomber japonicus*, and the cephalopods *Sepia officinalis* and *Loligo* sp. This extensive variety of prey inhabits an equally diverse selection of habitats, and includes benthic-reef and sandy-bottom prey and their associated predators, pelagic schooling fish and cephalopods, and deeper-water fish (Wells and Scott, 1999 and refs. therein).

Off Peru, both coastal and offshore dolphins consumed Pacific sardines, anchoveta, and hake, but demersal species such as sciaenids and toadfish were found only in coastal dolphins. By contrast, the offshore animals were the only ones with mesopelagic fish and squids in their stomachs (Wells and Scott, 1999 and refs. therein).

The stomachs of bottlenose dolphins stranded on the Mediterranean coast of Spain contained mainly cephalopods and fish, hake (*Merluccius merluccius*) being the most important single prey species. Based on stomach contents, feeding habits were considered to be mostly demersal (Blanco et al. 2001).

Although individual feeding is perhaps most prevalent, co-operative herding of schools of prey fish has been reported from a number of regions. In Mauritania and Brazil, dolphins regularly drive schools of mullet towards fishermen wading with nets in shallow water, and in other regions they have been observed feeding behind shrimp trawls and in the vicinity of small purse seines, collecting discarded fish from these operations after the nets are retrieved, and stealing fish from a variety of fishing gear (Wells and Scott, 1999 and refs. therein).

**Schooling:** Group size is commonly less than 2,010, but large herds of several hundred to a thousand are regularly seen offshore (Bloch, 1998; Wells and Scott, 2002). Bottlenose dolphins are commonly associated

with other cetaceans, such as pilot whales, white-sided, spotted, rough-toothed and Risso's dolphins, and humpback whales, and hybrids with other species are known from both captivity and in the wild (Jefferson et al. 1993; Bloch, 1998; Wells and Scott, 1999).

**Reproduction:** Spring and summer or spring and autumn calving peaks are known for most populations (Jefferson et al. 1993; Wells and Scott, 2002).

## 5. Migration

According to Wells and Scott (1999, and refs. therein; 2002), little is known about the ranging patterns of pelagic bottlenose dolphins, but coastal dolphins exhibit a full spectrum of movements, including 1) seasonal migrations, 2) year-round home ranges, 3) periodic residency, and 4) a combination of occasional long range movements and repeated local residency. Long term residency may take the form of a relatively permanent home range, or repeated occurrence in a given area over many years. For example, the residents of several dolphin communities along Florida's west coast have maintained relatively stable home ranges during more than 28 years of observations. In other areas, residency is long-term but more variable: Dolphins seen frequently during 1974–1976 in Golfo San Jose, Argentina, showed a subsequent decline in frequency of occurrence, but were still occasionally identified in the area 8–12 years later.

Along the central west coast of Florida, communities of resident dolphins appear to inhabit a mosaic of overlapping home ranges. The home range of the Sarasota dolphins encompasses an area of about 125 km<sup>2</sup>. Most of the activities of the residents are concentrated within the home ranges, but occasional movement between ranges occurs also. The same applies to bottlenose dolphins off San Luis Pass, Texas (Maze and Würsig, 1999). Within the home range, habitat use varies with season, with shallow estuarine waters frequented during the summer and coastal waters and passes between barrier islands used during the winter (Wells and Scott, 1999 and refs. therein). However, behaviour may also vary among animals within the same area: Simoes-Lopez and Fabian (1999) found that in Laguna, southern Brazil 88.5% of the individuals were resident and the rest were non-resident.

Dolphins living at the high latitude or cold water extremes of the species' range may migrate seasonally, as is the case along the Atlantic coast of the United

States. It has been suggested that some dolphins may use seasonal home ranges joined by a travelling range: a 4-month cycle of occurrence of dolphins was observed in Golfo San Jose, Argentina (Wells and Scott, 1999 and refs. therein). Wood (1998) investigated a group of bottlenose dolphins in the coastal waters of Cornwall, UK in 1991. The dolphins demonstrated a seasonal residency pattern, spending the winter in southern Cornwall and moving further north-eastward during spring and summer. Residency was flexible with a number of individual dolphins using the region intermittently. The dolphins occupied a linear coastal range of 650 km. Within this range they repeatedly made long-distance journeys. The longest journey recorded covered 1,076 km and took 20 days.

Similar observations were recently also published by other authors: Wilson et al. (1997) report that members of a population of *Tursiops truncatus* resident in the Moray Firth off north-eastern Scotland were seen in all months of the year, but there were consistent seasonal fluctuations in the number of individuals present. Numbers were low in winter and spring and peaked in summer and autumn. Individuals exhibited rapid movements across the population's range. For instance, one individual was sighted at locations 190 km apart within a 5-day period.

Finally, in the Faroes, the bottlenose dolphins are observed all year round but with peaks in March and July-October (Bloch, 1998).

Barco et al. (1999) investigated patterns of abundance and distribution for coastal migratory *T. truncatus* that appear seasonally in the nearshore waters of Virginia Beach, Virginia. A profile analysis of variance revealed significant differences in local abundance and distribution throughout the year. Dolphin number was positively correlated with water temperature whereas the influence of prey distribution and abundance was unclear.

Defran et al. (1999) conducted boat-based photo-identification surveys of bottlenose dolphins from 1982 to 1989 in three discrete coastal study areas within the Southern California Bight: Santa Barbara, Orange County, and Ensenada (Mexico). A high proportion of dolphins photographed in Santa Barbara (88%), Orange County (92%), and Ensenada (88%) were also photographed in San Diego. 58% of these 207 dolphins exhibited back-and-forth movements between study areas, with no evidence of site fidelity to any

particular region. Minimum range estimates were 50 and 470 km. Minimum travel-speed estimates were 11–47 km/d, and all dolphin schools sighted during the study were within 1 km of the shore. These data suggest that bottlenose dolphins within the Southern California Bight are highly mobile within a relatively narrow coastal zone and are presumably influenced by variation in food resources. Defran and Weller (1999) add that 1) the combination of regular dolphin occurrence, 2) low site fidelity by known individuals, and 3) the continuous increase in the rate at which new dolphins were identified indicates that numerous different individuals were visiting the study area across and within years. The open California coastline differs in habitat structure and prey distribution from more protected study areas where bottlenose dolphins display site fidelity, which may explain the observed intraspecific behavioural variability of this species.

Long distance movements have been reported from southern California in the early 1980s (Hansen and Defran, 1990) subsequently expanding the species' recent range more than 500 km northward in conjunction with an El Niño warm water event (Wells and Scott, 1999 and refs. therein). Following the El Niño, some dolphins remained in northern waters, while others returned to their previous range to the south. Würsig (1978, in Wells and Scott, 1999) reported a 600 km round-trip for several identifiable dolphins in Argentina. Tanaka (1987) reported that a satellite-tracked dolphin off Japan apparently travelled 604 km in 18 days along the Kuroshio Current.

Long-distance migrations are presumably also undertaken by offshore bottlenose dolphins, whose diet is comprised of highly migratory species of fish and squids. In a recent paper, Acevedo-Gutiérrez and Parker (2000) show that dolphin behaviour and spatial arrangement of their prey are closely linked. Off California, offshore bottlenose dolphins may extend their range northward to the area of the Northern Channel Islands, principally during summer and early fall. Off Peru, catches of the offshore form occur mostly during the summer, indicating some west-east migration (Reyes, 1991 and refs. therein).

Wells et al. (1999) tracked two rehabilitated adult male bottlenose dolphins with satellite-linked transmitters in 1997. "Rudy" was equipped in the Gulf of Mexico off central west Florida. He moved around Florida and northward to Cape Hatteras, NC, covering 2,050 km in

43 d. "Gulliver" was released off Cape Canaveral, FL. He moved 4,200 km in 47 d to a location north-east of the Virgin Islands. Gulliver swam through 5,000-m-deep waters 300 km offshore of the northern Caribbean islands, against the North Equatorial Current. These records expand the range and habitat previously reported for the offshore stock of bottlenose dolphins inhabiting the waters off the south-eastern United States and illustrate the difficulties of defining pelagic stocks.

## 6. Threats

**Direct catch:** Directed fisheries taking bottlenose dolphins have previously occurred around the Black Sea as well as in Mexico, Guatemala, Costa Rica, the West Indies, Venezuela, Sri Lanka, and off southern Africa, India and Peru. Drive fisheries for bottlenose and other dolphins were also reported from the Republic of China (Taiwan), but the numbers are not known. The species is taken in a drive fishery in the Faroe Islands which dates back to 1803, annual takes numbering from 1–308, often in mixed schools with long finned pilot whales (*Globicephala melas*) (Reyes, 1991 and refs. therein; Bloch, 1998).

In Peru, coastal fisheries still take *Tursiops* and other cetaceans for human consumption, using gill nets, purse seines, and harpoons and a similar fishery occurs in Sri Lanka (Wells and Scott, 1999 and refs. therein; Wells and Scott, 2002). Although direct killing has noticeably decreased since dolphin hunting was banned by law in 1996, around a thousand dolphins and other small whales are still falling victim annually to fishermen to supply bait meat for the shark fishery (2003, see "Mundo Azul" in "selected seab-sites"). The most significant take probably occurs off Japan, where bottlenose dolphins are killed for human consumption, bait and because of perceived competition with fisheries (Wells and Scott, 2002). Reported catches were: 230 in 1986; 1,813 in 1987 and 828 for 1988. (Reyes, 1991 and refs. therein).

**Live captures:** More than 530 *Tursiops* have been taken from US waters since the passage of the Marine Mammal Protection Act of 1972 (MMPA), particularly from the south-eastern USA. Present federal regulations limit the annual allowable take to less than 2% of the minimum estimated population in designated management areas, but no bottlenose dolphins have been collected in US waters since 1989. Some small scale live-capture fisheries continue in other countries (Wells and Scott, 1999 and refs. therein).

**Incidental catch:** Fisheries around the world account for incidental takes of bottlenose dolphins, but the present level of take remains unknown. Gillnet and purse-seine fisheries off Peru take an unknown number, but rough estimates are in the hundreds.

In the western Mediterranean incidental catches have been reported in trawl fisheries and in the driftnet swordfish fishery. Some tens are also taken in several other fisheries throughout the range.

Read et al. (2003) report that in North Carolina interactions between dolphins and gill nets are common and that many of these interactions are food-based. Surprisingly, however, dolphins engaging in depredation do not appear to become entangled; instead it seems more likely entanglement occurs as a result of dolphins failing to change course around the net.

The estimated annual incidental mortality in the eastern tropical Pacific fishery for tuna ranges from 0 to almost 200, although it makes up only a very small fraction (less than 5%) of the total small cetacean mortality in the fishery (Reyes, 1991 and refs. therein).

Incidental catches in Chinese fisheries reach several hundred per year (Yang et al. 1999), and a large incidental take of *Tursiops* has apparently occurred in the Taiwanese gill net fishery off Australia, with an annual mortality perhaps exceeding 2000 animals.

The use of shark nets to protect bathing beaches in South Africa and Australia has caused mortality as well. Dolphins were found with full stomachs, indicating recent feeding in the vicinity of the nets and there was a correlation of mortality rates with the direction of the prevailing current. Attempts to prevent the animals from entangling by incorporating active and passive devices in the net were not successful. The relatively high incidental catches of coastal dolphins off South Africa has prompted concerns that the take is not sustainable (Wells and Scott, 1999 and refs. therein).

According to Northridge (2003) a high proportion of the common dolphins that strand on the south coast of England in winter months bear evidence of fishery interactions. It is not known which fisheries are involved, but the number of stranded by-caught dolphins has raised concerns for their conservation status. Observers have monitored 149 days at sea since 2000, and have recorded 61 common dolphins taken in trawl

nets. All of these animals were recorded in trawl tows targeted at bass. Preliminary mitigation trials using pingers were not effective, with no reduction in dolphin catch rate when pingers were deployed around the mouth of the trawl. Current work is focussed on using exclusion grids to allow dolphins to escape from the sleeve of the trawl.

**Killing:** *Tursiops* have been intentionally killed by fishermen in Japan and Hawaii and presumably such practices are found elsewhere in their range (Reyes, 1991). The Japanese drive fishery off Iki Island and the Kii Peninsula takes several hundred *Tursiops* annually to reduce the perceived competition with the commercial fishery for yellowtail, *Seriola* sp. (Wells and Scott, 1999 and refs. therein).

**Pollution:** Their worldwide distribution and great adaptability to diverse habitats make this species a good indicator of the quality of inshore marine ecosystems. There are reports of DDT, PCBs and heavy metals in bottlenose dolphins from the western Mediterranean, with higher levels of DDT and its metabolites (Reyes, 1991 and refs. therein).

Concentrations of polychlorinated biphenyls and dieldrin were measured in the blubber of South African specimens. First-born calves received 80% of their mother's body burden of contaminant residues, perhaps leading to increased neonatal mortality. Accumulation of contaminants in tissues of males reached levels that theoretically could impair testosterone production and thus reduce reproductive ability (Wells and Scott, 1999, and refs. therein). Preliminary results of research by Lahvis et al. (1995) indicate that even relatively low levels of PCBs and DDT such as those found in the blood of Sarasota dolphins can result in a decline in immune system function.

Focardi et al. (2000) determined concentrations of tributyltin (TBT) and its degradation products, monobutyltin (MBT) and dibutyltin (DBT), in the liver and kidney of bottlenose dolphins found stranded along the western Italian and Greek coasts in the period 1992–1994. Butyltin (BT) compounds were detected in almost all the samples analysed and were higher in the kidney than in the liver. BTs were found to be transferred from mother to fetus. Le et al. (1999) found higher butyltin concentrations in coastal as opposed to offshore *T. truncatus* from waters around Japan indicating land-based sources.

Frodello et al. (2000) determined mercury levels in various organs of specimens stranded along the Corsican coast between November 1993 and February 1996. In all cases, the liver appears to be the preferential organ for mercury accumulation, with concentrations as high as 4,250 µg Hg/g dw. Mercury levels found in livers may integrate mercury uptake having occurred during the whole life span of the animals.

Watanabe et al. (2000) determined concentrations of polychlorinated biphenyl congeners (PCBs) and organochlorine pesticides in the livers of bottlenose dolphins stranded on the coasts of Florida and found that hepatic concentrations were greater than those in the blubber of marine mammals of other regions, suggesting the presence of sources for these chemicals in the south-eastern US.

**Tourism:** Excessive and unregulated visiting of wild dolphins habituated to humans has raised concern in several areas, in particular in Europe (Reyes, 1991 and refs. therein). Nowacek et al. (2001) conducted focal animal behavioral observations during opportunistic and experimental boat approaches involving 33 well-known identifiable individual bottlenose dolphins off Sarasota, Florida. Dolphins had longer interbreath intervals (IBI) during boat approaches compared to control periods (no boats within 100 m) and the duration was inversely correlated with distance to the nearest boat in opportunistic observations. Dolphins decreased interanimal distance, changed heading, and increased swimming speed significantly more often in response to an approaching vessel than during control periods. These findings provide additional support for the need to consider disturbance in management plans for cetacean conservation (Yazdi, pers. comm.).

However, in Zanzibar waters, in the Western Indian Ocean, dolphin tours are organised from Kizimkazi, since local fishermen realised that their touristic value far exceeded that of using them as bait for sharks. As many as 2,000 tourists visit the dolphin site at Kizimkazi per month and dolphin-tourism is currently becoming a popular economic activity. Successful management of the dolphin-tourist trade will ensure continued visitors to the villages where dolphins are present and thus add income to these villages while contributing to management and conservation (Ali and Jiddawi, 1999).

**Overfishing:** Reduction of fish stocks by pollution or overfishing may affect dolphin populations such as

those in the Black Sea, which has been severely depleted by intense hunting which continued until 1983 (Reyes, 1991 and refs. therein).

## 7. Remarks

The coastal nature of bottlenose dolphins makes them particularly susceptible to human impacts. Mass mortalities have led to increased awareness of the possible cumulative and synergistic effects of habitat alteration, pollution, fisheries, vessel traffic, offshore industrial activity, and other human activities (Wells and Scott, 1999).

The EU Habitats Directive 1992 (Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora) states that places within the natural range of small cetaceans important for biological factors essential to their life should be designated as a Special Area of Conservation. A recent investigation by Sykes et al. (2003) has highlighted that, in accordance with this legislation, the Bottlenose dolphins of the Dorset coast (England) require protection that is currently not provisioned.

One of the major threats are the incidental take throughout their range and the directed fishery for food in Japan and other countries. Concern has been expressed about the levels of commercial fisheries in the Black Sea, which eventually could reduce the amount of food available to the dolphins and ultimately become a source of competition and conflict (Reyes, 1991).

Since studies reveal that coastal bottlenose dolphins may move considerable distances within their home range, it should be expected that in several cases members of these populations may regularly cross international boundaries (i.e., the home range of the population in southern California may extend across the boundary with Mexico). Further studies on the source, dynamics and effects of pollutants on marine mammals as well as the extent of fishery interactions will benefit the conservation of this and other cetacean species (Reyes, 1991).

Peddemors (1999) summarises for the coast of Africa, south of 17°S, that more research emphasis should in future be placed on possible detrimental interactions due to overfishing of delphinid prey stocks. Increased commercial fishing pressure will inevitably increase interactions between the fishery and the affected delphinids. One of the inshore species considered to be vulnerable is the bottlenose dolphin in KwaZulu-Natal

and Namibia. The bottlenose dolphin population in Namibia appears localised in its distribution and may therefore also be vulnerable to any future coastal development or commercial fishery expansions, while in KwaZulu-Natal they are subjected to ongoing incidental catches in shark nets, heavy pollution levels, habitat destruction and increased competition with fishermen for limited food resources.

For recommendations on South American stocks, see Hucke-Gaete (2000). See also general recommendations on Southeast Asian stocks (Perrin et al. 1996) in Appendix 1 and Appendix 2 respectively.

Only populations of *Tursiops truncatus* in the North and Baltic Seas, western Mediterranean and Black Sea are listed in Appendix II of CMS. However, because individuals of this species can either be resident, share a wide home range or migrate, it is suggested that all *Tursiops truncatus* populations should be included in app. II of CMS.

Range states include most nations of South, Central and North America, Africa, Europe, Oceania, Australia and Asia:

Ireland, the UK, The Netherlands, Belgium, France, Spain, Portugal, Morocco, Mauritania, Senegal, Gambia, Guinea-Bissau, Guinea, Sierra Leone, Liberia, Côte d'Ivoire, Ghana, Togo, Benin, Nigeria, Cameroon, Gabon, Rep. Congo, Dem. Rep. Congo, Angola, Namibia, Rep. South Africa, Mozambique, Madagascar, Tanzania, Kenya, Somalia, Djibouti, Yemen, Sudan, Egypt, Saudi-Arabia, Oman, Abu-Dabi, Katar, Bahrain, Iraq, Iran, Pakistan, India, Bangladesh, Sri Lanka, Myanmar, Thailand, Malaysia, Indonesia, Australia, New Zealand, Papua New Guinea, The Philippines, Cambodia, Vietnam, China, North and South Korea, Japan, Russia, the USA, Mexico, Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, Panama, Colombia, Ecuador, Peru, Chile, Argentina, Uruguay, Brasil, French-Guyana, Surinam, Guyana, Venezuela, Santo Domingo, Haiti, Cuba, Belize, Jamaica, the Bahamas.

The species is listed as "Data Deficient" by the IUCN.

The bottlenose dolphin is protected by national legislation in a number of countries, usually through general cetacean protection provisions.

*Kindly reviewed by Dorete Bloch, Museum of Natural History, Thorshavn, Faroe Islands.*

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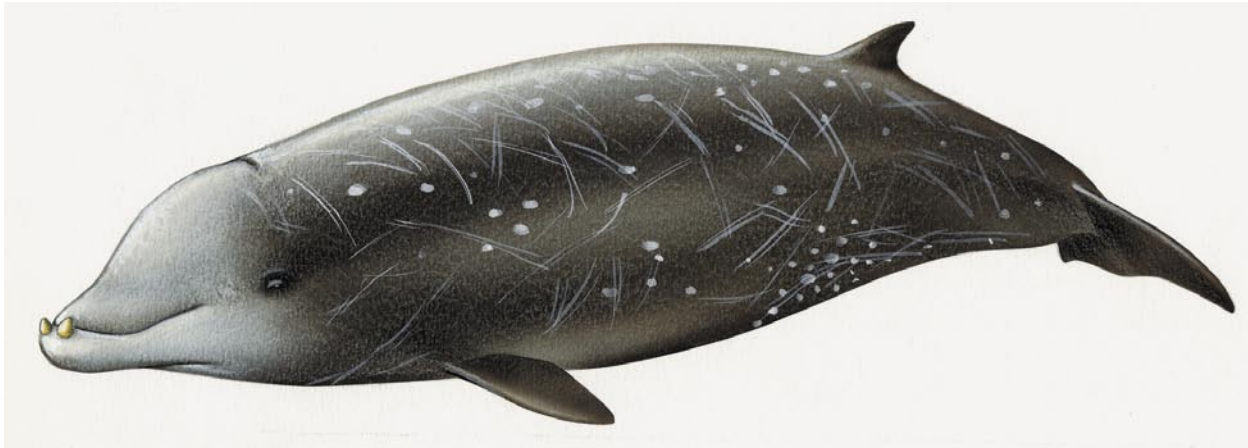
## 5.71 *Ziphius cavirostris* (G. Cuvier, 1823)

English: Cuvier's beaked whale, Goosebeak whale

German: Cuvier-Schnabelwal

Spanish: Ziphio de Cuvier

French: Ziphius



Drawing of *Ziphius cavirostris*  
© Wurtz-Artescienza.

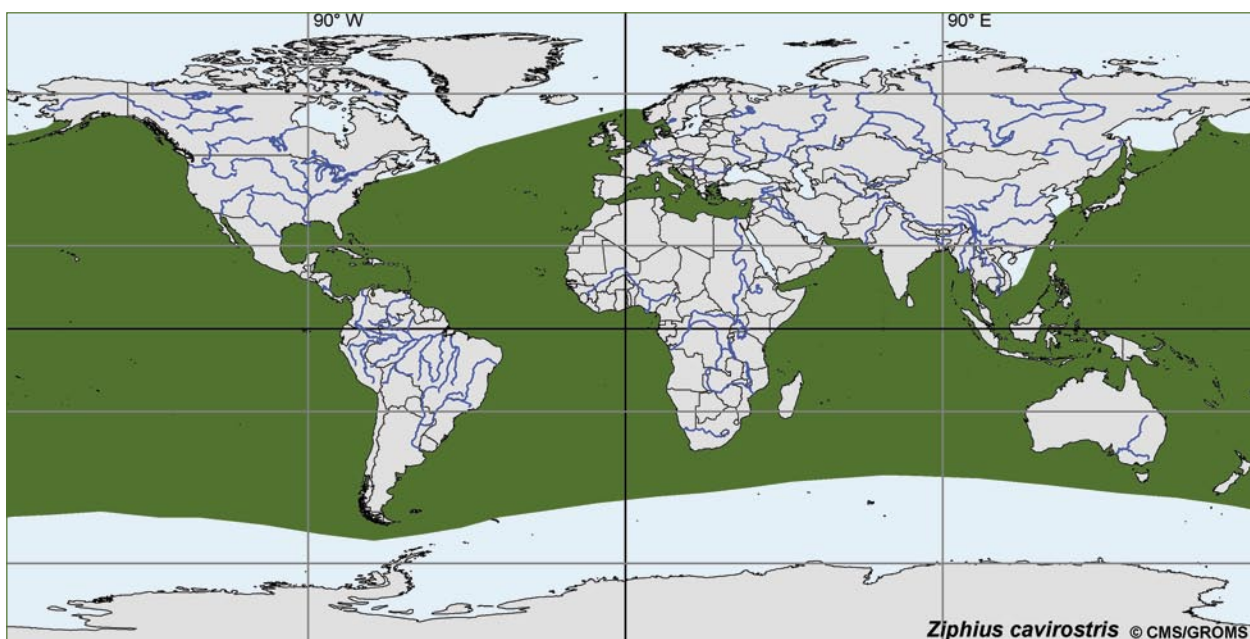
### 1. Description

The general body shape of *Z. cavirostris* is similar to that of other beaked whales: rather robust, cigar-shaped, small falcate dorsal fin, relatively small flippers. The flippers can be tucked into a slight depression along the body wall. The flukes are proportionately large, as in other ziphiids. The head is rather blunt in profile with a small, poorly defined rostrum that grades into the gently sloping melon. Pigmentation is dark slate grey over most of the body, with a distinctively white head in males and a slight lightening of the skin in females. Light oval patches attributed to cookie-cutter sharks

(*Isistius* spec.) and linear marks due to intraspecific fighting between males (which have two apical teeth) are common. The largest adult male was 7 m long (Heyning, 2002).

### 2. Distribution

All temperate and tropical waters around the world, north to Massachusetts, the Shetland Islands, the Mediterranean, Honshu, the Aleutian Islands, and the northern Gulf of Alaska; south to Tierra del Fuego, Cape Province in South Africa, Tasmania, South Island



Distribution of *Ziphius cavirostris*: world-wide distribution in tropical, subtropical, and temperate waters (mod. from Carwardine, 1995; © CMS/GROMS).

of New Zealand, and the Chatham Islands (Rice, 1998).

Cuvier's beaked whales may have the most extensive range and may be one of the most abundant of any beaked whale species. They are fairly common in certain areas, such as the eastern tropical Pacific (Jefferson et al. 1993; Heyning, 1989). However, they are generally inconspicuous and rarely seen at sea. They are known mainly from strandings (see Heyning, 1989, for a detailed list) and are found stranded more often than most other beaked whales. The species is absent only from polar waters (in both hemispheres; Carwardine, 1995). Geographical variation has not been analysed (Rice, 1998).

### 3. Population size

Strandings of *Z. cavirostris* are the most numerous of all beaked whales, indicating that they are probably not as rare as originally thought. Observations reveal that the blow of *Z. cavirostris* is low, diffuse and directed forward, making sightings more difficult, and there is some evidence that they avoid vessels by diving. These two facts may be the reason for the relatively few sightings made at sea (Heyning, 1989).

Waring et al. (2001) provide a stock assessment for all beaked whales in the western North Atlantic including *Z. cavirostris* and *Mesoplodon* spec. and come up with a minimum figure of 2,400 animals.

### 4. Biology and Behaviour

**Habitat:** Off Japan, whaling records indicate that *Z. cavirostris* is most commonly found in waters deeper than 1000 m (Heyning, 1989 and refs. therein). *Z. cavirostris* is known around many oceanic islands, and relatively common in enclosed seas such as the Mediterranean and Sea of Japan. It is a year-round resident in Hawaiian waters and several other areas. It is rarely found close to mainland shores, except in submarine canyons or in areas where the continental shelf is narrow and coastal waters are deep (Carwardine, 1995) and is mostly a pelagic species which appears to be confined by the 10°C isotherm and the 1000-m bathymetric contour (Houston, 1991; Robineau and di Natale, 1995).

**Behaviour:** They normally avoid boats but are occasionally inquisitive and approachable, especially around Hawaii. Breaching has been observed, though it is probably rare. (Carwardine, 1995). Dives of up to 40 minutes have been documented.

**Schooling:** Cuvier's beaked whales are found mostly in small groups of 2 to 7, but are not uncommonly seen alone (Jefferson et al. 1993). Most of our knowledge of the various ziphiid species comes from stranded individuals or animals taken in whaling operations (Willis and Baird, 1998).

**Food:** Cuvier's beaked whales, like all beaked whales, appear to prefer deep water; they feed mostly on deep sea squid, but also take fish and some crustaceans (Jefferson et al. 1993). Blanco and Raga (2000) investigated the stomach contents of two Cuvier's beaked whales stranded on the western Mediterranean coast. Food consisted exclusively of hard cephalopod remains, which agrees with the offshore and deep diving behaviour of *Z. cavirostris*.

Nishiwaki and Oguro (1972, in Heyning, 1989) found that stomach contents from *Z. cavirostris* caught off Japan varied consistently with a predominance of squid from animals taken in waters slightly under 1000 m in depth, with fish being the most abundant prey item found in animals taken in deeper waters. *Z. cavirostris* could thus be somewhat opportunistic in its feeding habits. It is interesting to note that most of the prey items found are either open ocean, mesopelagic, or deep-water benthic organisms, concurring with the idea that *Z. cavirostris* is an offshore, deep-diving species (Heyning, 1989). For details on beaked whale diet and niche separation see also the account on Mesoplodont whales (page 154).

### 5. Migration

In the north-eastern Pacific from Alaska to Baja California, Mitchell (1968, in Heyning, 1989) summarised the stranding record to date and found no obvious pattern of seasonality to the strandings. Robineau and di Natale (1995) summarise that there are seasonal differences in strandings recorded from the French coast with peaks in winter and spring, whereas strandings in the Mediterranean seem to peak in winter. Carwardine (1995) summarises that there is no information on migrations and nothing is reported in the more recent literature.

### 6. Threats

**Direct catches:** In the past, there have been a few small cetacean fisheries that have taken Ziphius. In the Japanese *Berardius* fishery, *Z. cavirostris* have been taken on an opportunistic basis with catches varying from 3 to 35 animals taken yearly. Although the *Berardius* fishery

still continues, there have been no takes of *Z. cavirostris* in recent years. The small cetacean fishery in the Lesser Antilles also occasionally took *Z. cavirostris* (Heyning, 1989, and refs. therein; Jefferson et al. 1993).

**Incidental catches:** Mignucci et al. (1999) conducted an assessment of cetacean strandings in waters off Puerto Rico, the United States and the British Virgin Islands to identify the factors associated with reported mortality events between 1867 and 1995. The bottlenose dolphin (*Tursiops truncatus*) was the species most commonly found stranded, followed by Cuvier's beaked whale. An increase in the number of strandings is evident over the past 20 years, averaging 63.1% per year. Between 1990 and 1995, the average number of cases per year increased from 2.1 to 8.2. The seasonal pattern of strandings was not found to be uniform, with a high number of strandings occurring in the winter and spring. The most common human-related cause categories observed were entanglement and accidental captures, followed by animals being shot or speared. Mora Pinto et al. (1995) report on by-catches from Colombian fisheries. Notarbartolo (1990) reports on by-catches in the Italian swordfish fishery. By-catches in the western North Atlantic are very low, with one animal reported between 1994 and 1998 (Waring et al. 2001).

**Pollution:** Analysis of tissues from a male from New Zealand found no traces of lead or organophosphates, but the following levels of potential toxins were noted: DDE, 1.2-mg/kg; DDT, 1.2-mg/kg; DDD, 0.25-mg/kg; and mercury, 1.9-mg/kg (Fordyce et al. 1979, in Heyning, 1989). Colin McLeod (2002, pers. comm.) did a review of stomach contents in beaked whales and found that at least 50% of Cuvier's beaked whales stranding on European coasts contain some plastics, while it is much rarer in northern bottlenose whales and *Mesoplodon* species. One possibility for this is that floating plastic sheets and bags either at the surface or at depth will act as fish attractors, providing shelter from predatory fish. Beaked whales being suction feeders, may then ingest the bag/plastic sheeting while 'hoovering' up actual prey which are hanging around close to the floating debris. For these suction feeders there would be little chance to "select" prey based on taste or feel as it will be in the mouth and swallowed before it is noticed.

**Acoustic pollution:** Frantzis (1998) found that a mass-stranding of 12 Cuvier's beaked whales in the Ionian Sea (Mediterranean) coincided closely in time and

location with military tests of an acoustic system for submarine detection being carried out by the North Atlantic Treaty Organisation (NATO). Although pure coincidence cannot be excluded, it seems improbable that the two events were independent. According to Balcomb (pers. comm.), NATO and the US Naval Undersea Warfare Center have calculated the resonance frequency of airspaces in Cuvier's beaked whales to be about 290 Hz at 500 meters depth, which is almost precisely the middle frequency of the sonar systems that were tested. Whale mortality during tests could therefore be due to resonance phenomena in the whales' cranial airspaces that are tearing apart delicate tissues around the brains and ears.

The connection between military tests and strandings is supported by the stranding of at least 12 specimens during a naval exercise off The Bahamas in March 2000 (Waring et al. 2001). Another 7 *Z. cavirostris* died in September 2002 during a naval exercise conducted around Gran Canaria, Spain (Vidal Martin, pers. comm.). High intensity Low Frequency Active Sonar (LFAS) was used by US and NATO vessels in these areas, respectively, which led to stranding of other species as well, including *M. densirostris* (see page 165).

Degollada et al. (2003) performed necropsies on ten carcasses in Gran Canaria between 24 and 72-h postmortem following standard procedures. The most remarkable features were inner ear hemorrhages and edema starting in the VIIIth cranial nerve and extending into the spiral ganglion and the cochlear channels. In addition, inner ear structural damages were found. These findings are consistent with the lesions observed in other organs, in particular the brain, confirming an acoustically induced trauma as the only non-discarded cause of death.

## 7. Remarks

Very little is known about this species. However, mass strandings after military sonar tests are a matter of concern and should be further investigated. Due to a lack of abundance data, the effects of by-catches in fisheries cannot be evaluated. Listed by the IUCN as "Data Deficient" and not listed by CMS. More information is clearly needed.

*Ziphius* also occurs in southern South America, therefore the recommendations iterated by the scientific committee of CMS for small cetaceans in that area (Hucke-Gaete, 2000) also apply. For recommendations

concerning south-east Asian stocks, see Perrin et al. (1996) in Appendix 1 and Appendix 2 respectively.

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